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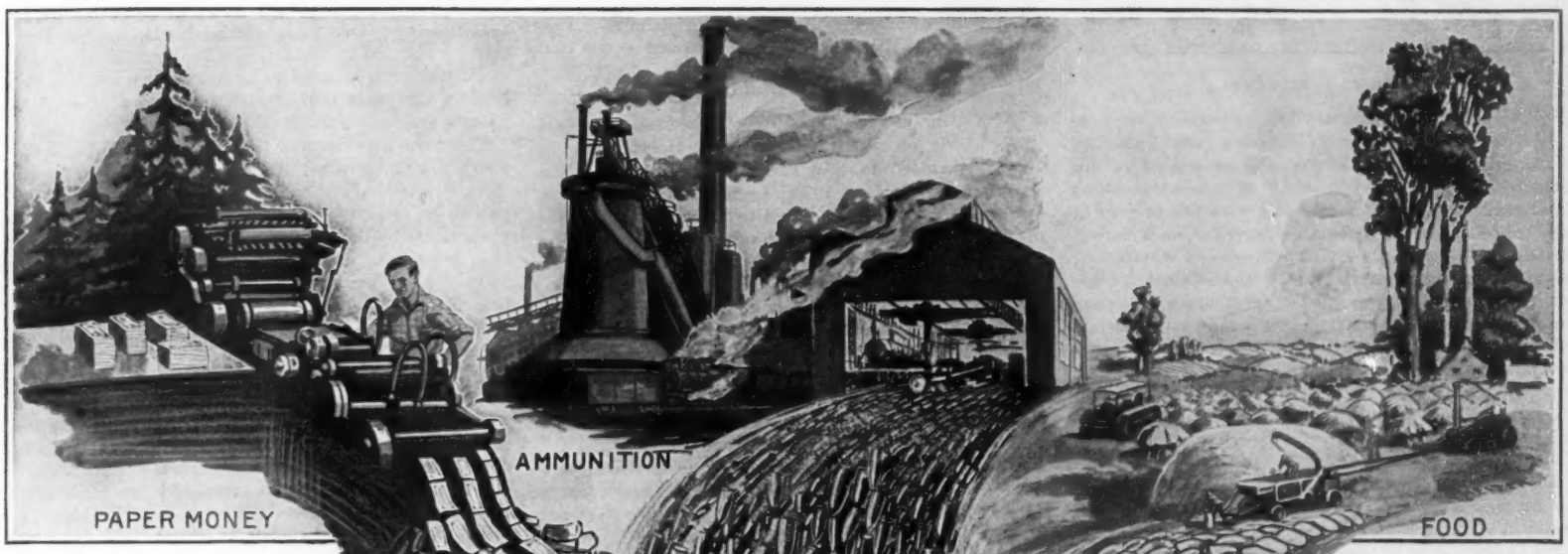

Why Germany Is Losing the War

The Remorseless Draining of Her Reservoir of Man-power

GERMANY is the backbone of the Central Powers' military organization. Shatter her, and the whole fabric of the enemy's opposition falls to the ground. Because of this fact, France, Great Britain, and, now, the United States have massed their strength in France and Flanders. For the same reason Germany has maintained in France and Flanders two-thirds of her total forces. Today she has practically the whole of her armies—or what is left of them—on the Western front and in Italy.

How may Germany be beaten?

In the early days of the war, when her armies were at their full strength, it was believed that the breakdown would come within her borders. We all remember the familiar predictions of 1915 and 1916. She was to suffer financial collapse; lacking cotton, nitre and copper, she would be unable to munition her vast armies; lacking food, she would starve.

Yet, today, with the fourth year of the war half spent, the German people are not starving for food; her armies are not starving for munitions; nor is she bankrupt, not at least in the eyes of her own people.

But, as year after year of the war passed by, it began to be realized that there was yet another menace to German success; a menace purely military in nature, remorseless in its approach, and absolutely fatal when it arrived—the menace of a shortage of man-power.

Today, among all military men and among those civilians who have managed to maintain a true perspective of this vast war, it is known that the backbone of German resistance will be broken when the wastage of man-power—rifle-bearing man-power—has reached the point where it is no longer possible to man the battle front in sufficient strength to hold back the enemy.

This wastage and the ultimate arrival at the point of man-exhaustion are a mere question of mathematics—of addition and subtraction; the result is as certain as that water will not run up hill, or that the whole is greater than its part.

Of the four great necessities referred to, failure of any one of which would bring Germany down, the first three may be likened to a constantly-flowing river—the last to a reservoir of definite capacity. There is a certain amount of uncertainty as regards the first three—but the last, unless Germany can gain an early military decision, spells her certain and hopeless defeat.

You may carry the bucket to the stream as often as you like; but dip your bucket in the cistern too often and one day you shall find it dry.

To no one are these facts so well known as to the German staff; and no part of the German propaganda has been so cleverly handled as that which is designed to camouflage that human cistern, the contents of which have been drained away so swiftly as the war has run its course.

"Look at the map," cries von Hollweg.

"Look at the cistern," we answer; and with our eyes on that annual loss of one and a quarter million German fighting men who will never again shoulder a rifle, we care very little whether the blood-letting be done a little to the east or a little to the west of a line traced on a map.

As to the bankruptcy of Germany, it can never happen so long as the Kaiser has a printing press to turn out a cataract of paper-money, and the German citizen is content to accept the output at its face value.

Nor will Germany fail to supply all the munitions that her rapidly-dwindling armies can use. She can dig coal and iron ore from her mines and coax nitrogen from the atmosphere for guns, shells and explosives—and keep on doing it indefinitely. The Serbian mines and the kitchen of the hausfrau will give their yield of copper. The stream will flow in sufficiency as long as the war shall last.

Food? There is enough arable land within the battle-lines to raise sufficient food to keep the citizen alive and provide a special ration for the man at the front.

Men? Before this war, military writers, the Germans included, told us that the proportion of the population in any country that could be made into fighting men was 10 per cent. The population of Germany is 68,000,000. As a matter of fact the mobilization has reached nearly fifteen per cent, and therefore in August, 1914, the potential fighting strength of Germany was about 9,500,000 men.

This was the reservoir from which the human material would have to be fed to the fighting lines. The nine and one-half million fighting men could never be affected by the birth rate—not unless the war should run for 18 years. The only supply available to offset the outflow was the physically efficient young men, some 450,000 who would reach the age of 18 each year. Unlike the question of paper money, or munitions or food, there is no process by which men can be printed in a printing press or fabricated in smelter, rolling mill and lathe. Nor can you dig up fighting men from the ground, like potatoes.

And not even the German chemists could make a substitute for human flesh and blood—though they probably dreamed even of that.

So there it stood at the beginning of the war, a cistern full to the brim with 9,500,000 men and with a potential annual inflow of 450,000.

Now let us see what has been the rate of loss. There are two ways in which we may get at the facts: first the German official statements; second, the estimates made by the Allied Military Intelligence Departments (Secret Service). And we find that these arrive at the same total loss—dead and hopelessly crippled—of about 5,000,000 men.

For the first two years Germany gave out official figures—doctored of course. But the Allies, through their secret service agents in Germany, gathered the true figures by tabulating the notices sent to the relatives of the dead, and recorded on the roll of honor of churches, clubs, labor unions, etc. This revealed that about 1,150,000 men had been killed or taken prisoners,

(Concluded on page 467)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Academic Freedom

THERE has been a great deal of discussion throughout the country concerning the summary dismissal from the faculties of several of our universities, notably Columbia, of members whose utterances with regard to the war were in one way or another felt to be prejudicial to Americanism and good citizenship. On the one hand it has been pointed out that the influence exercised over the student by his collegiate instructors is in the very nature of things enormous, and that it is therefore incumbent upon the latter to exercise the greatest circumspection in every utterance which can possibly be classified as one of personal opinion. Then, too, it has been shown that certain views are not at present compatible with the national interest, and that academic free speech must expect to suffer along with free speech in other channels. On the other hand, it is urged that it is highly improper for an honest professorial mind to be subjected to the arbitrary restraint of trustees, that the professorial intelligence must in the nature of things be superior to the business intelligence when it comes to such questions as are here involved, and that any restraint must necessarily shackle instruction to ideas which are, to quote one dismissed educator, narrow-minded and medieval.

We have from the first had a very marked suspicion that the advocates of academic decency had a stronger case than the exponents of academic freedom; likewise that most of the arguments advanced on both sides, and which we have endeavored just now to compress into a paragraph, were quite beside the mark. The readiness with which the most violent radicals were prepared to concede that there had to be set some limit upon class-room inculcation of lawlessness and immorality has confirmed both impressions; for this reduces the whole controversy to a matter of definition, and some properly constituted authority must exist possessing the power to define. But we have not previously seen the case presented with such clarity as by President Butler of Columbia, in his recent annual report to his trustees; and we accordingly take the liberty of borrowing some of his words and his ideas to set before our readers.

President Butler quotes the clever definition of academic freedom as "freedom to say what you think without thinking what you say," and proceeds to show that there is no ground for fear that academic freedom, whether so or otherwise defined, is in the slightest danger in this country. What is constantly in danger, however, is a just sense of academic obligation. When a teacher accepts an invitation to become a member of a certain academic society, he automatically loses some of the freedom that formerly was his. He has voluntarily accepted the restrictions put upon him by the traditions and purposes of the institution with which he has associated himself. Try as he may, he can no longer write or speak in his own name alone. Were he to succeed in so doing, what he might have to say would, in nine cases out of ten, carry no significance and gain no hearing. What he writes or says gains significance and a hearing because of the prestige of the academic society to which he belongs. To that prestige, with all that the word means, the academic teacher owes a distinct, a constant, and a compelling obligation. To maintain one's connection with an academic society while at war with its purposes or disloyal to its traditions and organization is neither wise nor just.

Neglect of academic obligation, or carelessness regarding it, gives rise to difficult problems. Men of mature years who have achieved sufficient note to be invited to occupy a post of responsibility in a university ought not to have to be reminded that there is such a thing as academic obligation or that they fall short in it. No matter how strongly they feel upon certain points, no matter how thoroughly convinced they are that they are on the side of right and truth, they should realize without reminder that they address their classes, and even their public audiences, not as Mr. So-and-So, but as Doctor So-and-so, of Blank University. If they dispute this fact, a glance at the title page of their newest books will make them concede it. This being the case, it is absolutely clear that, regardless of what their own opinion be, regardless of what may ultimately turn out by agreement of the race to be recognized as right, regardless even of what may be the state of general contemporary opinion upon the matters of their discourse, they are not at liberty to retain their University connection while they preach what the University stamps as heresy.

With the thing presented in this light, it is extraordinary that there should be found any to argue it. Freedom of thought the teacher must have; freedom of discussion with his academic colleagues, by all means yes; but freedom to impose upon receptive minds, in the name of the University, doctrine of which the University explicitly disapproves—emphatically, no! The professor whose views are not those of his institution can no more claim the privilege of giving them forth under the cloak of his University connection than can the miserable handful of hyphens who went to Stockholm claim to represent America. It is a clear case of conform or get out.

The War and the Domestic Furnace

TO win the war for democracy is the most important task on earth today. Everything must be sacrificed to that end. This statement needs no argument—in fact, it has been made so often that our senses have become dulled to its importance. Not until we begin to feel the pinch of want are we fully impressed with the fact that each one of us must strain every effort to accomplish the great purpose.

The Conservation Division of the Fuel Administration is now endeavoring to show every householder how he can help win the war in his own furnace. The war is making severe demands upon our coal resources. This year we must increase our output 100,000,000 tons above normal. It is not to the mines that we must look for this increase. Owing to car shortage and the congested condition of the railroads, the increased supply will not be more than 50,000,000 tons, which leaves 50,000,000 tons still to be accounted for. We shall not hesitate for a moment to levy this amount from the normal domestic and industrial consumption, and hand it over for use in the war; but can it be taken without serious industrial and domestic inconvenience? The United States Fuel Administration believes that it can.

On another page will be found some suggestions offered to the householder by the Federal Bureau of Mines, acting in coöperation with the Fuel Administration. These suggestions should be followed out carefully by every consumer of coal, in order that the fuel may be used with the utmost economy. Not only will this result in a saving for the individual, but it will be a distinct service to the nation. If every householder in the country should reduce his consumption by one furnace shovelful of coal per day during the six winter months, there would be a saving for the entire country of 25,000,000 tons, or half of the national shortage due to the demands of the war. If householders will follow the instructions that come with their furnaces, or will write to the makers of these furnaces for advice as to the most economical use of fuel, they will be able to effect an even greater average saving. Every householder, should keep an account of the number of shovelfuls of coal used per day, with the same diligence that he uses in keeping track of his household expenses.

To be sure, uneconomical methods are also to be found in industrial establishments. The burden of making up the deficiency is not to be borne by the householder alone. The Fuel Administration has undertaken a campaign of education among manufacturers as well. However, if voluntary economy on the part of industrial and domestic consumers does not make up the shortage, the Fuel Administration may have to impose limitations on the manufacture of non-war products. It is to be hoped, however, that no such interference with established industries may be necessary. It certainly will not be necessary if every individual feels that he is personally responsible for the economical use of fuel.

Is the German U-boat an American Invention?

HAD it not been for the use of two American inventions, German naval and military power would have succumbed before this to the might of the Allied Powers. Indeed, it may be said that two American inventors, Maxim with his machine gun and Holland with his submarine, have thus far saved the German Nation.

Were it not that an advancing force, breaking through the enemy lines, melts rapidly away before the storm of bullets from the concealed machine guns of the enemy, the Germans would have been driven across the Rhine long before this. Were it not for the shortage of shipping brought about by the illegal use of the submarine, the German front would have crumbled before the onslaught of the fully-munitioned forces of France, Great Britain, Russia and Italy.

In the present article we propose to show that the much-vaunted U-boat of the Germans represents, in its fundamental principles, a wholesale appropriation of the American submarine, as originaly developed by Holland some fifteen years ago.

And in this connection we wish to record that when Simon Lake saw the first war photographs of the U-boats, he noted their general likeness to one of his boats, the plans of which he had given a few years previously to the Krupp firm, when they and a Russian Syndicate were contemplating the constructing of a fleet of submarines for the Russian navy. These plans Mr. Lake has never been able to recover, although the scheme of construction fell through and Mr. Lake made many requests for his plans.

In the mine-laying U-boat recently exhibited in Central Park, New York, was to be found indispensable evidence that the Germans had appropriated *in toto* the principles of the American U-boat as worked out successfully by Holland.

The fundamental ideas embodied in the original Holland boats and which underlie all the successful work that has been done in submarine boats, and were certainly embodied in the German boat exhibited in Central Park, were reduced to practical form by Mr. Holland in the years 1897 to 1901, and are covered by patents granted on applications filed in the year 1901.

The most important of these basic principles, is that which might be called the "lighter-than-water" principle, which is embodied in Mr. Holland's United States patent of June 17th, 1902. This involves the use of main water ballast tanks having a fixed capacity, such that when the tanks are *full* they overcome the buoyancy of the normally emersed portion of the boat less a certain reserve buoyancy. Associated with this are a propelling engine and horizontal rudders, whereby the boat, although it is lighter than water, may be made to dive, to run while submerged, and to return to the surface without varying the amount of water ballast. This arrangement not only provides a safety factor, due to the fact that, if the engines break down, the boat will come to the surface, but it is essential to the easy handling of the boat when submerged. If the boat, when ready to submerge, were heavier than water, the slightest variation in the inclination of the axis of the boat, or in the position of the horizontal rudders, would send the boat rapidly to excessive depth. In fact, the boat would have a natural affinity for the bottom. By making the boat lighter than water, it shares, with its crew, a natural affinity for the surface.

The second basic principle developed by Holland is disclosed in his patent of February 25th, 1902, and it involves an addition to the ballast system just described. This takes the form of an auxiliary ballast tank, having a center of gravity in the same transverse plane with the center of buoyancy of the boat, and of sufficient capacity to compensate for the variations in density of the water and for the variations in the weight of the stores, fuels, munitions and crew within the boat.

A third principle, of perhaps minor importance, is disclosed in the Holland patent of June 17th, 1902, and involves the distribution of the weight within the boat, so that the center of gravity is slightly aft of the center of buoyancy when the main ballast tanks are empty, together with such positioning of the main ballast tanks that, when they are filled, the center of gravity is moved into line with the center of buoyancy. As a result of this arrangement the boat trims by the bow when the ballast tanks are empty and the boat is running on the surface, but is brought to an even keel when the main ballast tanks are filled. This makes possible the rapid change from the surface running condition to a condition ready for diving, without any redistribution of the ballast in the forward and aft trimming tanks. It is impossible to say, absolutely, that the U-boat had this characteristic; but so far as one could estimate, the distribution of the weights and the arrangement of the main ballast tanks corresponded with this patent.

A fourth feature which is known to have been embodied in the German boats relates to the compensation for the discharge of torpedoes, so that the discharge may be effected without varying the trim of the boat. This involves fundamentally the idea of permitting the torpedo tubes to fill with water when the torpedo is discharged, and then transferring this water in the boat, so as to compensate for the weight of the torpedo. The German boat was a mine layer and it is impossible to tell whether it had this feature or not. This compensation is a very important factor in the operation, and it has been carefully developed in the Holland boats. The fundamental idea is disclosed in the Holland patent granted September 24th, 1901, and various developments of it are represented in patents to Lawrence Y. Spear and Frank T. Cable. In the latest Spear patent of July 11th, 1911, which represents the highest development of the arrangement, the compensation for the movement of torpedoes is effected by transferring water from the forward trimming tank to the aft trimming tank, and that is probably the arrangement employed in the German boat.

Naval and Military

Captive Balloons on Trawlers.—One more danger is added to the already large list which every U-boat must face in the war zone, the latest being the use of captive balloons on trawlers. These slow-moving boats operating off the coast of France, are now provided in some instances with a captive balloon which is sent aloft with observers. At a height of a thousand feet or more, the observers command a wide stretch of water, and on calm days can see even below the surface of the waves for a considerable distance. Submarines in this manner may be spotted and followed.

Germany Calls Her Boys of 16.—Despite constant assurances to the contrary on the part of German propagandists, there is proof sufficient that Germany is finding it difficult indeed to maintain her armies at anything like full strength. From Amsterdam comes a despatch stating that Germany is planning to force boys of 16 and 17 years into the army. In an appeal appearing in the Essen *General Anzeiger*, the boys are urged to join the Juvenile Corps. "This great struggle between the nations," says the newspaper, "will necessitate those who are now 16 and 17 being called up at no very remote date for army service."

How Our Railroads Are "Doing Their Bit."—Troop movement figures up to November 24th indicate that the railroads of this country have safely transported approximately 1,500,000 soldiers to training camps and embarkation points since August 1st, according to the *Army and Navy Journal*. Five hundred thousand of these men have made journeys necessitating overnight travel and have been moved in tourist or standard sleepers furnished by the Pullman Company. On one of the long hauls, 8,000 men were moved from a training camp on the Western coast to a point on the Eastern coast—a distance of 3,700 miles in a little less than a week.

Clothing for Men on Patrol Duty.—Only the officers and men who have had to endure the rigors of patrol work in the North Sea and the northern waters of the West Atlantic understand what a severe strain this is upon the endurance and constitution. Further, our fleet is usually sent to southern waters, with Guantanamo, Cuba, as a base, during the winter weather. Now, however, their patrol duties in European waters are subjecting them to the most severe exposure. Speaking on this subject, Thomas C. J. Peoples, of our Navy, explained before the House Appropriations Committee that the prospects of a winter's campaign in extremely cold waters necessitates unusual weight of clothing from the inner garments out. The special garments now being made for these forces include: 200,000 windproof shirts, 200,000 windproof trousers, 200,000 blanket overshirts, 190,000 pairs of arctics, 200,000 pairs of mittens, 250,000 suits of underclothing, 403,500 pairs of heavy wool socks, and 10,000 pairs of high leather sea boots.

Camouflaged Roads in the War Zone.—Although numerous photographs of camouflaged roads have been published in this country, there still remains to be published a correct explanation of how the overhead screen camouflage accomplishes its purpose. Thanks to an Italian airman who has flown over camouflaged roads, we are able to tell just why a series of canvas strips stretched over a thoroughfare at certain intervals, effectively conceals the traffic. In brief, the action is simply this: When flying directly over any given point, the traffic on the road can be plainly seen if it happens to be directly underneath the airman. But when the airman tries to observe the road in either direction from a point directly below him, he merely sees the screens which, overlapping because of his angle of vision, present the appearance of a solid tunnel or tube. Obviously, the position of the road is not hidden; but all traffic is effectively concealed unless the observer happens to be directly overhead, and it is for this very reason that this form of ingenious camouflage is so often resorted to.

Latest Achievements of the Tanks.—As an effective weapon of war it seems that the tank has a brilliant future, not only when its construction will have been considerably improved upon, but especially when tank tactics are developed to a fine point as a result of considerable experience with them. French tanks played an important rôle in the last battle of the Chemin des Dames, when the Germans were swept off the Aisne heights and into the valley beyond. Tanks of the latest design, more powerful and more heavily armed than the earlier French tanks, were used to good advantage in destroying troublesome machine-gun nests and in breaking up stubborn groups of German infantry. In some instances the tanks had to fight their way uphill and cross deep ditches and shell holes. More recently, the British tanks distinguished themselves in the battle of Cambrai, at the head of General Byng's infantry which swept forward without the usual artillery preparation. We are told that the tanks maneuvered about in squad formation and were entirely successful in tearing down great stretches of the enemy's barbed wire entanglements and in smashing his concrete shelters and dispersing his machine gunners. Considerably over a hundred tanks were employed, according to reports.

Science

A Committee on Civil Aerial Transport has been appointed to consider problems relating to commercial aeronautics, aerial mail service, and the utilization of military aeroplanes and aviators after the war for non-military purposes. This step is in line with the pronounced movement in Europe for the furtherance of similar objects. Dr. W. F. Durand, chairman of the National Advisory Committee for Aeronautics, is also chairman of the new committee, and the other members are Professor Marvin, Chief of the Weather Bureau; Dr. Stratton, director of the Bureau of Standards; Lieut.-Col. V. E. Clark, Signal Corps; and Lieut-Commander J. H. Towers, of the Navy. Other members will probably be added.

Lifting the Cattle Tick Quarantine.—Since the year 1906 the joint efforts of federal and state authorities have succeeded in releasing from quarantine against the cattle tick 379,312 square miles of territory, or more than 51 per cent of the area originally quarantined. Mississippi has just celebrated with special ceremonies her release from this scourge. She is the fifth state to be declared entirely free from the tick. The area in the entire South which still remains to be released from federal quarantine is 349,250 square miles. According to the Department of Agriculture, "indications from all the tick-infested states are that in many sections the people have grown thoroughly tired of the toll the tick is taking and are patriotically building dipping-vats and making preparations to free their cattle during the coming year."

Pasteurization of Milk.—The importance of pasteurizing milk is now almost universally recognized. The practice has been advocated by the U. S. Public Health Service since 1907. In October last the quasi-national Commission on Milk Standards, appointed by the New York City Milk Committee, adopted a resolution urging the pasteurization of the milk used by American soldiers. It was recommended "that all milk, including that which enters into the preparation of milk products, especially ice cream, be pasteurized and the efficiency of the process be controlled; that such milk be reduced to a proper temperature at the source of supply and kept at that temperature during transportation and until consumed; that the specifications for the purchase of milk be in conformity with the standards recommended by this Commission."

Nitrogen Acids in Rainfall.—A committee of the British Association for the Advancement of Science has recently collected samples of rainfall, during a period of one year, at 16 stations scattered over the continent of Australia, and examined them quantitatively to determine their content of nitric and nitrous nitrogen. About 1,000 samples were examined, and the results were compared with the records of the weather conditions under which the rainfall occurred. The general conclusions are that, for a given type of weather, the concentration of oxidized nitrogen in the rainfall varies inversely as the amount of rainfall, and that the total amount of oxidized nitrogen per unit area found in the rainfall accompanying a storm depends upon the type of weather and is practically independent of the amount of rainfall. The highest total amounts of oxidized nitrogen were found at southern and inland stations in rain-water resulting from monsoonal storms following a heat wave.

The Demand for Textile Plant Fibers.—Mr. Lyster H. Dewey, who for some years has had charge of the fiber-plant investigations of the U. S. Department of Agriculture, set forth in a recent lecture some interesting facts regarding the present urgent need of a greater production of textile plant fibers and the steps that are being taken to supply such material. The shortage is due to the reduced production of flax and hemp in Russia and jute in India, together with difficulties of transportation and increased consumption. He stated that flax is not now regarded as absolutely necessary for tablecloths and napkins and has long since given place to cotton in most so-called linen collars and shirts, but it is needed for the wings of aeroplanes and must be largely used in shoe thread. "Ireland's 107,000 acres of flax, double the area devoted to this crop in pre-war years, and the marked increase up to 39,000 acres in Japan are helping out the supplies, while hemp and cotton are used more than ever before as substitutes." The price of hemp has increased from six cents a pound before the war to 16 cents now. In the United States the acreage devoted to hemp has grown from 4,000 to 41,000 in the past three years. Jute, normally used to a greater extent than any other fiber except cotton, is nearly all produced in India, where the crops of the past two years have been deficient. The most promising substitutes for this fiber are low-grade hemp and flax. There is a shortage of henequén (Yucatan sisal) for binder twine; the best substitute now available in this country is American-grown hemp. The scarcity of fibers has one bright side, says Mr. Dewey; it has made American spinners appreciate the possibilities of American-grown fiber as they have not done heretofore.

Electricity

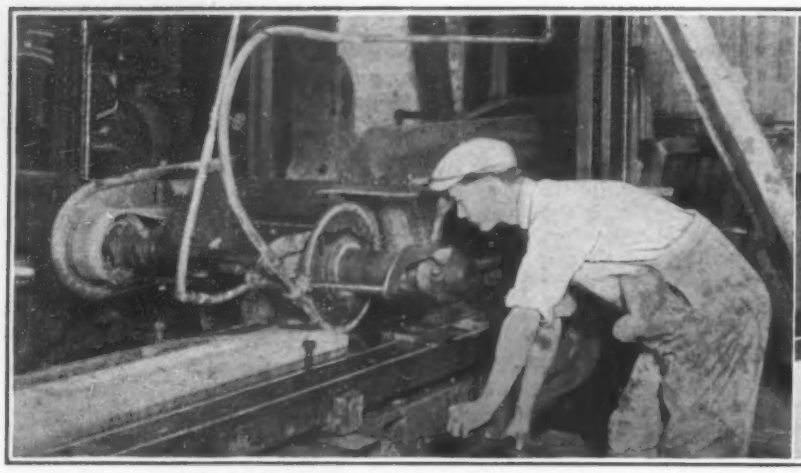
Electricians Wanted in the Army.—The United States Army needs electricians and men of many other trades such as iron workers, automobile mechanics, etc., to serve in the Army along the lines of their civilian occupations in this country and abroad. Enlistment is open to citizens of the United States or to those who have declared their intention of becoming citizens. They must be between the ages of eighteen and forty-five years and have no one depending upon them for support. Men who can qualify for the above positions will be examined physically at recruiting headquarters, 357 Broadway, New York City. Military training is not required, nor are strictly military duties exacted except in emergencies.

A Non-Glaring Lighting Unit.—Will full appreciation of what glaring lighting units mean to the efficiency of workers in stores, offices, shops and factories, a manufacturer of fixtures has just introduced a device which minimizes glare. The unit is composed of two essential elements, an upper reflector of white porcelain-enameled steel, and a porcelain-enameled reflecting band which is suspended from the upper reflector in such position that it will intercept all light within the angles of 45 degrees and 85 degrees and direct it to the upper reflector for redirection to useful angles. In this manner, glare within the normal range of vision is entirely eliminated, and, it is further claimed, this elimination is accomplished with very little loss in efficiency of the unit. The outfit is practically an indirect unit, since direct light comes through only a small opening below the tip of the lamp bulb.

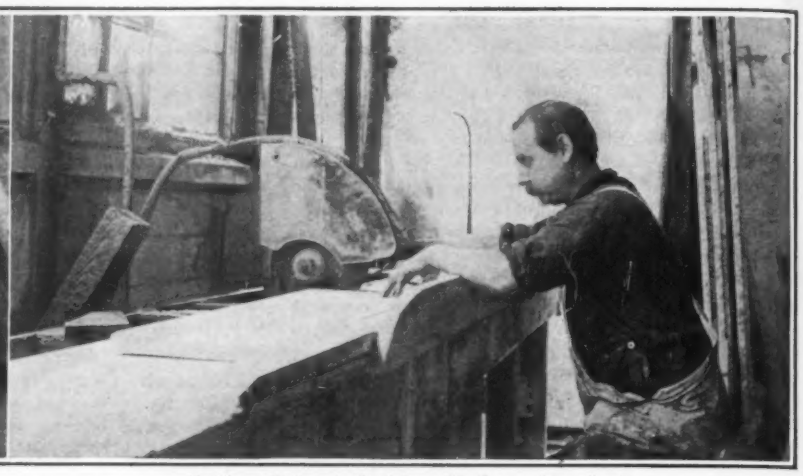
A Tin Pyrometer.—There has been recently introduced a tin pyrometer for measuring temperatures above the thermocouple range with the use of a direct insertion pyrometer. According to the *Electrical World*, the tin is contained in a graphite bulb and expands through a graphite capillary tube. In this way the metal is subject to a reducing atmosphere, which tends to maintain a bright surface and keep the metal pure and free from dross. The expansion of the graphite is almost negligible in comparison with that of the tin. The tin does not appreciately evaporate until a temperature of presumably 2,000 degrees C., is reached, so that no difficulty in change of calibration is encountered. A steel tube containing an insulated contact is lowered down to the capillary tube until it makes a contact with the surface of the tin and thus completes a circuit through an electric buzzer or sounder. The height of the tin is indicated by the position of the upper end of the steel tube which holds a pointer that moves beside a scale. Since the contact is insulated in quartz, which has an inappreciable thermal expansion, the inaccuracy is negligible.

A Telephone with Double Membranes.—In the *Annales des Postes, Télegraphes et Télephones*, an account is given of an interesting form of telephone receiver for which several advantages are claimed. It consists of a vessel furnished at its base with a membrane facing an electro-magnet, as in an ordinary receiver. But above this membrane is placed a hollow cone, the base of which contains a second membrane, parallel to and a few millimeters away from the first. The cone contains a second electro-magnet in series with the first one, both being traversed by the speaking current. As a result the hearing value is stated to be doubled. Moreover, the second membrane only covers about two-thirds of the first, and the annular space thus presented between the membranes and the ear has a favorable effect on the conduction of sound to the ear, tending to suppress inconvenient crackling effects and resonance. In addition, the condenser-effect of the telephone, which is generally regarded as the chief cause of resonance troubles, is considerably diminished by this new device. According to the patent the method is also applicable to microphones.

The Passing Away of William Duddell.—On Sunday, November 3d, the electrical world lost one of its ablest workers in the person of William Duddell, who passed away at the early age of 45. Born in London in 1872, Duddell was destined to become one of the leading figures in modern electrical development; and early in his career he developed his ingenious oscillograph for the study of alternating current wave forms. Some time later he conducted an exhaustive and highly interesting series of experiments on the direct-current arc, and it was during these experiments that he evolved the musical or singing arc which he found to act as a generator of high-frequency current. In recent years wireless investigators have made use of Duddell's musical arc in the development of wireless telephony and long-range wireless telegraphy, and Duddell himself turned his attention to wireless, developing remarkable instruments for detecting weak electrical currents. So thoroughly did he apply himself to the development of radio communication that he was elected president of the Commission Internationale de Télegraphie sans Fils in 1914, whose investigations were soon interrupted by the great war.



The machine that cuts out the slabs of marble



Cutting off the stock slabs with the coping wheel

Modern Marble and Granite Working

The Processes by Which the Hardest Blocks are Worked as Freely as Wood

By Raymond Francis Yates

THE blackened ruins of the majestic Parthenon of Athens stand today as an enduring consecration to the artistic nature of the early masters of architecture who immortalized their ideals with such utter boldness and beauty. The noble and beautiful buildings they designed appear simple, yet their erection involved such delicate technique that they have defied duplication throughout the centuries and the lost art that brought about their creation is still as remote as the Philosopher's Stone.

Man has at his disposal many discoveries and inventions that offer him indespensable aid in stone cutting today, but the ancient Greeks had nothing but the crude chisel with which to form the various parts of their buildings. Modern stone cutting is an exact science and where it took the Greeks years to form a structure, the same work could be accomplished today in a few months by some of the large stone working concerns. Modern methods of marble and granite cutting form an important chapter in industrial science, the unfolding of which should prove of interest to the layman.

As marble is a very hard and resistant substance, the task of forming and cutting it is a difficult one. Ordinary steel tools are unsuitable and in many parts of the operation it is impossible to use them. It was the advent of modern artificial abrasives, notable among them carborundum, that brought about radical changes in the marble industry, and many operations have been reduced from hours to minutes by the use of these substances with their unprecedented hardness and their unapproached sharpness and cutting power.

Marble slabs are now sawed in much the same manner as wood, and in many cases, nearly as fast. Previous to the introduction of the modern devices now used in this operation, the diamond-toothed saw found universal employment, although it had many objectionable features and shortcomings. It consisted merely of a steel disk with diamond points mounted on its periphery. The disk or "saw" was made to revolve at a high speed and the point of contact with the marble was well lubricated with water flowing under pressure. One of the recent developments in the trade, which takes the place of the diamond saw, is a steel disk equipped with carborundum teeth which are placed at regular intervals around the periphery of the disk, and which are easily detachable, being held in place by means of a wedge. When the teeth wear down they can be quickly and easily replaced at little expense. Such a saw, of course, is used only in cutting large marble or granite blocks, several feet in thickness. For cutting thin slabs of marble, a small steel disc with a continuous rim of abrasive material bonded to its periphery is used in place of the saw, and, when traveling at a speed of 7,500 surface feet per minute, this device is capable of cutting six feet of 1¼-inch marble in one minute.

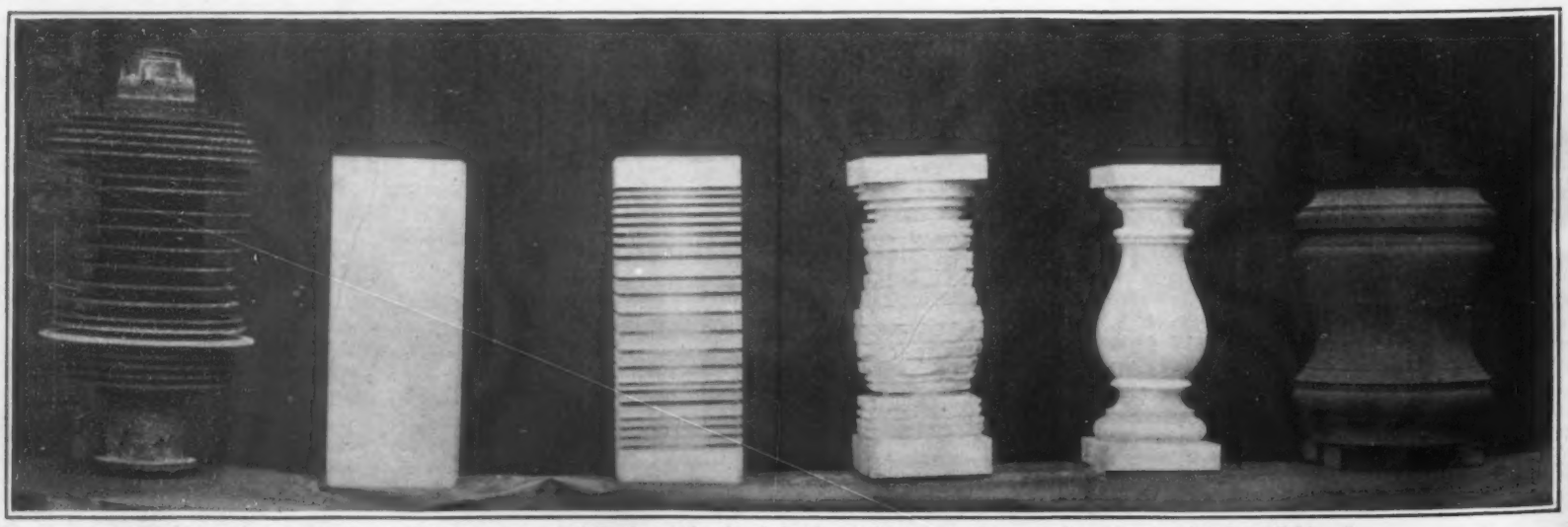
The polishing head at work. Small blocks of abrasive substance revolve rapidly upon the marble surface, bringing it to a high finish

After large marble or granite blocks have been cut by means of the saw, many irregularities or "winds" are left on the surface and these must be obliterated before the final operation of honing and polishing is applied. The approved method of removing the winds and squaring the surface after the block comes from the gang saw, is to run the piece under what is known to the trade as a "drum rubber." This consists of a cylinder of abrasive material mounted on a shaft which revolves over a horizontal traveling table to which the work is anchored. One passage under the drum is sufficient to remove all irregularities and a cut as great as ⅜-inch can be made.

In lathe work, abrasives have almost entirely replaced steel cutting tools, with a resultant saving of time and elimination of waste, as the steel tool was always a factor of uncertainty and either broke or ruined the work when a "flint" or hard spot in the marble or granite was struck. This is not the case when using abrasives as they cut flints as easily and quickly as they do the rest of the stone and without the least possibility of destroying the work.

A good example of the lathe work accomplished today by the use of abrasives is shown in the illustration which depicts the various operations in the production of marble balusters. First, the square block is cut as shown, by putting it in a lathe and slotting it by means of a series of coping wheels, mounted on a single shaft. After this operation, the baluster is chiselled down, put into a lathe and brought to bear against a revolving carborundum drum which, in shape, is just the reverse of the baluster it is proposed to turn out. The drum used is generally made up of various shaped wheels mounted on a single shaft. By this method it is possible to produce perfect balusters of practically any design.

The same type of wheel that is used for producing balusters is equally adaptable to the making of moulding. By anchoring the rough stock to a table and running it under a molding wheel of abrasive material at the proper speed it is possible to produce simple designs by one cut.

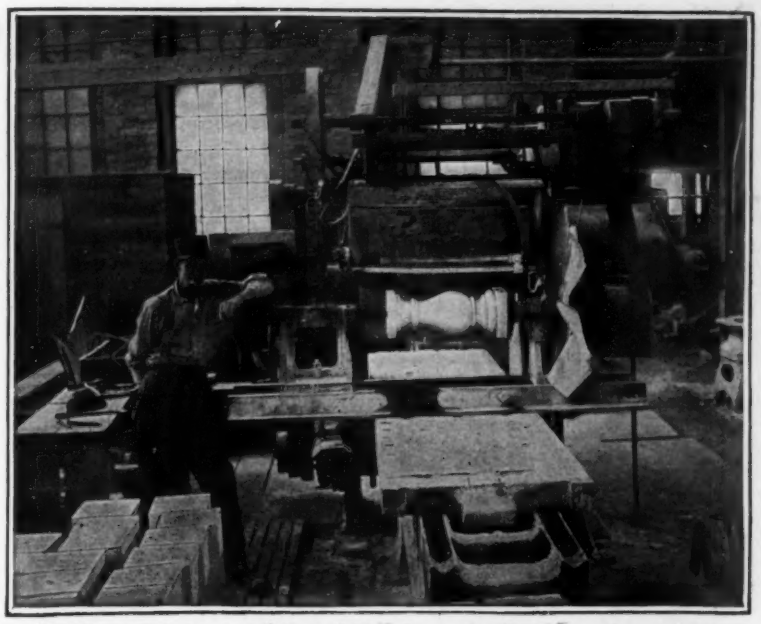


Successive stages of a marble stair post. At left, the cutting head that is used to create the second stage; at right, the polishing drum, made by placing together a number of separate lifts

Of course, with the more elaborate designs it is necessary to make several cuts before the product is finished. Coarse grit wheels are capable of removing ¾-inch of stock at a single cut. By the old method of cutting marble molding it was only possible to produce very simple designs at great cost and considerable labor. By means of the present day methods, any operator can produce the most beautiful designs, with little time and expense, as far as his labor is concerned.

The process of polishing marble or granite consists of three operations technically known as roughing, second gritting, and honing. The machine used for these various operations is shown in the illustration and is known to the trade as a "grinding head." The machine causes small blocks or segments of an abrasive substance to revolve rapidly upon the stone surface to be finished. During the operation a continuous supply of water is forced through the shaft of the grinding head, which is made hollow for this purpose. The pressure of the grinding head upon the work is controlled by the operator, who can move the spindle vertically by means of a handle. The next operation, second gritting, is accomplished with the same machine, the only difference being that blocks of a finer grit are used. The final operation is also done with the same machine and blocks of a very fine grit are used which leave the surface with a beautiful polish. Thus we see that each stage of the process further finishes the operation that preceded it until a perfect surface results.

Large marble columns are made in sections which are turned out on a giant lathe. The method of fluting marble columns is similar. The sections are anchored to a table which travels under two thin grinding or coping wheels driven by an electric motor at high speed. These wheels cut two slots where the proposed flute is to be. A stone cutter then chips out the material between the parallel shots and a grinding wheel is again run down the flute or channel to finish it.



Finishing off the post with the polishing drum of carborundum shown above

Better Railroad Ties

By O. P. M. Goss, Consulting Engineer

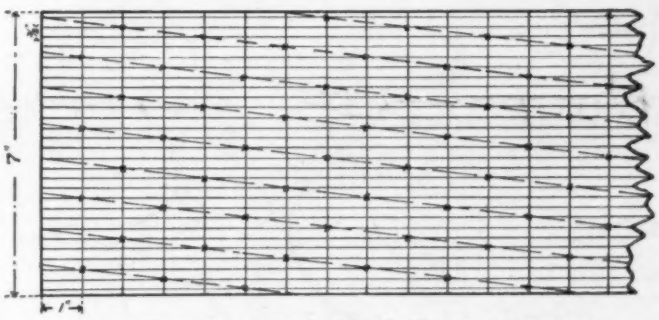
ONE of the heavy items of expense that our railroads are striving to bring to a lower level is that of tie replacement. Careful selection of the timber best suited to this use is a factor; and recently another avenue of attack has been opened by the development of the creosoting treatment, which greatly slows up the processes of decay.

This, however, is not the last word. While decay is the chief enemy of the railroad tie, it is not the only one. Heavy steam traffic produces a terrific pounding; and while the roadbed supports part of this, the tie must in the very nature of things take up much of the impact. The western roads have found that creosoted Douglas fir gives about as satisfactory a tie as is available in that territory, one with a normal life of six or seven years. But while creosoting is a necessity in order to prevent a decay whose effects would be far worse than those of the pounding, the treated ties stand up poorly under the impact stresses. The problem of tie conservation is then reduced to that of finding what feature of the treatment it is that weakens the wood, and altering that feature. This problem has been solved by an association of northwestern lumbermen.

After extensive experiments, it became evident that the loss in strength of the creosoted timbers was due mainly to the high temperatures and pressures used in the treatment. The resistance of the wood to the entry of the oil was so great that the fiber had to be broken down to a considerable degree to secure the necessary penetration. And even then the wood does not take the creosote with any approach to uniformity. So a method of introducing the oil was sought which would be at once less violent and more thorough. This sounds like a large contract; but the conditions named have been successfully met.

It is plain that oil, like anything else, will enter wood more readily along the grain than in any other direction. Of course no one would try to drive the creosote through the entire tie from the ends. But it seemed within the possibilities that the lateral surfaces might be studded with holes, of such depth and so distributed that creosote introduced into them under mild pressure would penetrate sufficiently along the grain to cover the ground between adjoining holes.

A large number of experiments were made to determine the best spacing of the holes, and the most advan-



The arrangement of punch holes finally adopted as best

tageous tool for punching them. The spacing, of course, would vary with the intensity of the treatment; but since the whole purpose was to reduce that intensity, a mild treatment was outlined, and the spacing determined with reference to it. The ties were heated in creosote oil under atmospheric pressure at 170 degrees Fahrenheit for four hours. At this temprature additional pressure was then applied, rising from 0 to 100 pounds per square inch in the first hour and remaining at that figure for two hours. Finally the oil was drained off and a vacuum of about twenty-four inches drawn for half an hour.

When the best type of perforating had been determined, it was in order to see just how good it was. Since it was known that creosoting in the ordinary way reduced the compressive strength of the tie about forty per cent, no tests were necessary in this direction. But it was necessary to know what effect the perforating and the mild creosoting outlined had upon the strength. Accordingly each tie tested was cut into three pieces; one to be tested for compressive strength in the natural condition, one after the treatment described without perforating, and one after perforation and treatment.

The results of these tests may be summarized in the statement that the average loss of strength under treatment for 100 ties was 0.5 per cent when unperforated and 2.9 per cent when perforated. Twenty of the heavier ties were actually stronger after treatment perforated than after the plain process; and in 36 cases the creosoted tie with the holes in it developed more resistance to pressure than the original piece in natural condition. Accordingly it may be concluded that the mechanical effect of the holes in reducing the strength of the tie is negligible, and that if the treatment with perforations shows any advantages it may be safely adopted.

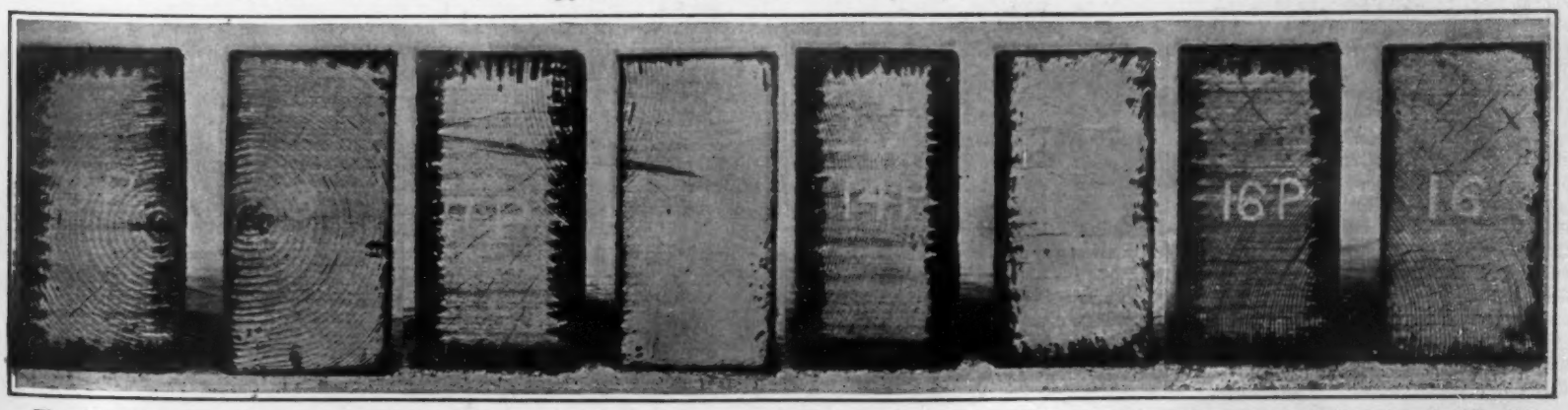
That it shows at least one advantage is evident at once; the old method cuts the resistance of the tie to pressure by 40 per cent, and this method reduces that resistance by less than three per cent. But this is not all, as our illustrations show. The old method of creosoting under high temperature and pressure, and the new mild treatment of unperforated ties, alike show the greatest lack of uniformity in their operations. But sections taken of ties creosoted after perforation by the new process show the greatest evenness of penetration; in every case the creosote appears as a broad black border of practically the same width throughout. Accordingly, the resistance to decay which is the object of the treatment is vastly more effectively obtained under the new process outlined than under the old.

The association making these investigations sums up its findings as follows:

"Cut ties in winter and early spring. Perforate, and open-pile them for air seasoning, taking advantage of the summer months. The perforations facilitate seasoning. The ties, after seasoning, may be treated as outlined above in the early fall and winter. Handling ties in this way will insure an absolute protection against decay, and will enable the wood to be creosoted without loss in mechanical strength, the two factors responsible for increased efficiency in the use of railway ties."

The Current Supplement

SUCCESSIVE discoveries of prehistoric remains have carried the time of the first evidences of the human race back to a period ages earlier than was supposed or admitted by scientists only a few years ago; but there are still many more problems that remain to be cleared up. A step in this direction will be found in the article on *Prehistoric Classification* in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2189, for December 15th. *Magic Behind the Trenches* gives a faint idea of the tremendous technical problems that are being worked out in France by the Allies. The article on *Chemical Laboratory Porcelain* tells of the requirements in this class of apparatus. *Archeological Notes on the Danish West Indies* is an interesting account of an investigation of certain prehistoric rock carvings in the islands recently acquired by the United States, illustrated by a number of excellent photographs by the author. The article on *Companions of the Sun* is concluded in this number. *How the Sun, Earth and Moon Move* describes and illustrates an ingenious astronomical model constructed with a view to making the movements of these celestial bodies clear to students and others. *Permanent Magnets* deals with the effect of chemical composition, shape, dimensions, heat treatment and usage on these instruments so important in electrical constructions. Among other articles of value are *Fires in Coal Storage Piles, The Fish Louse, A Note on a Possible Explanation of Erratic Jumps in Clock Rates* and *War Time Smuggling.*



The old and the new methods of creosoting ties. Each pair of blocks is from the same piece of lumber; the result of the new process appears at the left, and of the old at the right. In every case the new method results in a deeper and a more uniform penetration of the oil

Strategic Moves of the War, December 6th, 1917

By Our Military Expert

THE scene has changed once more to the western front, which has recently witnessed the most spectacular and dramatic advance of either side during the present war. This has been the British advance in the surprise attack that found the Germans off their guard between Arras and St. Quentin, and gained for the assailants great gaps in the former Hindenburg lines west of Cambrai that, when consolidated, meant a forward movement, on a front of thirty or thirty-five miles, to a maximum extent of five to seven miles. This advance has brought the British forces in some places to within three miles of the great railroad center and German supply depot of Cambrai, one of the keys to the whole German western position. The general direction of the movement was from the west toward Cambrai along the Bapaume road and from the southwest along the Peronne-Cambrai railroad.

The remarkable feature of the whole victory is that it was carried out without artillery preparation, the British troops moving forward in the wake of great land fleets of tanks that broke their way through barbed wire entanglements and lumbered across hostile trenches of any width, enfilading the latter with machine and heavy gun fire as they passed. When tanks were first employed, the general impression was that these engines of war were rather freaks than of any great value. But the work that they have done since the first day of employment is certainly one of the most striking features of the war; they have always, as in this great battle, literally driven the entering wedge in a battle, without which not much would probably have been accomplished. Their employment has also rendered possible a secret attack which would not have been the case had it been necessary to bring artillery into play to open the fight. The use of artillery always gives notice where an attack is to be expected and furnishes an opportunity to mass reserves and guns to repel it. Under these heads the tanks have fully demonstrated their power both in saving the lives of soldiers and in conserving the ammunition supply.

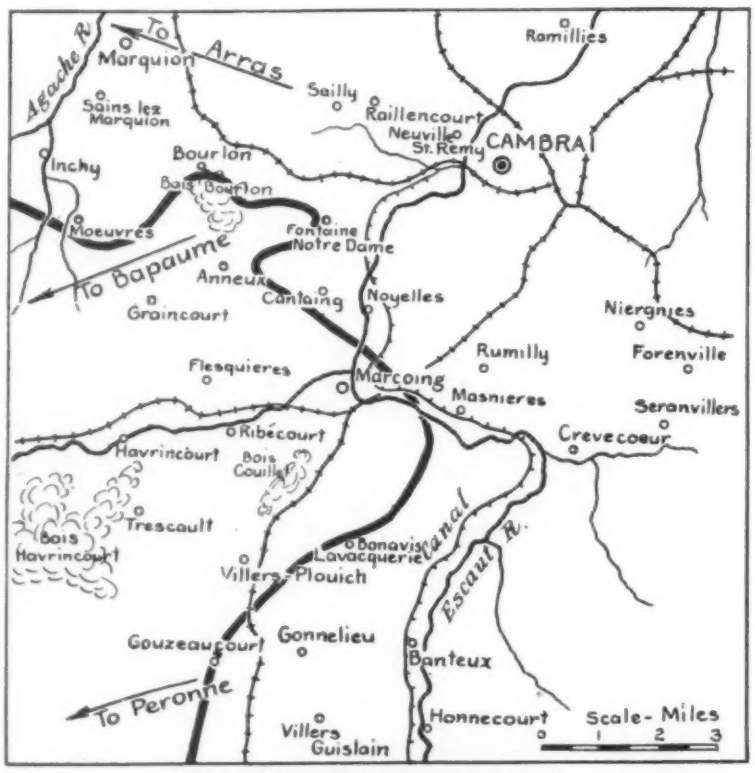
But it must not be concluded that all credit for the victory gained in the first stage of the present advance and for the progress that has been made should be given to machines; it was also due to the generalship that could conceive and execute such a surprise attack; the success of machines was only secondary. The facts are that the British commanders outgeneralled their German opponents in the movement.

It is true that attacks without adequate artillery preparation have been previously made; but they have resulted in terrible slaughter of men without adequate results. The victory at Cambrai was mainly due to the fact that it was a successful surprise attack—that is, the Germans were struck when they were not expecting it. The English commander did not find any new way to break the German lines; he simply put into operation methods centuries old. He managed a surprise concentration of men and of guns in front of a line of the enemy that was both undermanned and insufficiently supplied with guns; his plan was successful but it does not mean that this will be the case in the near future.

At the present writing the advance upon Cambrai is at a standstill for the German resistance has also stiffened due to bringing up reserves of men and guns from other parts of the front. The fighting has been particularly violent from two attacks—one of which extended from Moeuvres to Bourlon wood on the north and the other over approximately a seven-mile front southwest of Cambrai between Vendhuile and Crevecourt on the Scheldt.

Both assaults were in strong force, the infantry being supported by a large number of newly concentrated German guns. North of Cambrai the Germans were held; but on the south they broke through the British line south of Villers-Guislan where, turning to the north, they succeeding in surrounding Gauche Wood, Gouzeaucourt, Gonneliue and LaVacquerie, capturing both prisoners and guns. At the latest writing, however, the British are mentioned as holding their own and even making some gains. The struggle here has been described as one of the most desperate and bloody of the war, the German losses in the assaults having been almost unprecedented. But this counter offensive of the Germans was a most brilliant, skillful and successful one and has reduced the extent of the British gains at least one-fourth. It cannot be denied that the British were taken by surprise on the southern flank of the wedge that they had driven into the German lines; it cannot be denied also that this attack has shown the Germans are still capable of strong offensive movements on the western front. Their success here has done much to restore to their troops the morale and prestige that have been so seriously shaken recently by their reverses at other points along this front.

It may be that as a whole the success of the British here may influence the Central Allies' plans in the Italian campaign now in progress by causing a withdrawal of forces to strengthen the western front. The gain of ground, in its influence on the Entente Allies plans, can be seen by a glance at the map of the theater of war. If a start be made at St. Quentin where the British lines join the French, the present advance should soon carry forward beyond that city to the north and east, as the British have stood for months practically on the outskirts of the town. The battle line ran in a zig-zag line to the northwest, passing in a general northwesterly direction to the east of Arras. About seven miles east of the center of that line is Cambrai, one of the great objectives and now strongly threatened by the British troops. To the northeast of Arras and six or seven miles from that city lies Douai where, if the rush can be continued, the British will no doubt soon be in striking distance as a result of their present advance. In fact, the German defense of supply lines and of communications from St. Quentin north through Cambrai and Douai to Lille is in peril and its fate would be soon decided if Cambrai



The Cambrai battle front on December 6th

should be taken. The British have, in other words, shaken the German front along a quarter of the distance from Rheims to the North Sea and in the center of that front; it needs no expert knowledge to judge the effects on either flank in case of a break at the center. It may be, however, that the Germans can hold on to Cambrai until the spring opens, due to their recent strong offensive.

This discussion has taken no account of the effects of a probable French advance under present conditions. Should the French move forward to threaten or take LaFère at the present time, they would also threaten Laon to the southeast. The latter has been secure behind the defences of the St. Gobain plateau; but a flank attack from the north and west would destroy the value of that citadel. An advance toward Laon would also link up with the recent gains of the French on the Aisne and Aillette Rivers southeast of Laon. It would be tightening the pressure by drawing the strings around the German defenders of St. Gobain who would either retreat or surrender. At present, it is safe only to surmise; no one can foretell the possibilities of the future. It can be stated, however, that if the Germans are driven out of Douai on the north and out of Laon on the south, they would be forced to take up a new defense line—possibly Mezières-Horsin-Maubeuge-Valenciennes-Lille. At the present writing the British hold, on the Cambrai front, Bourlon wood and the heights to the north of the Bapaume-Cambrai high road together with the villages of Anneux, Noyelles and the edge of Masnières across the Scheldt River—in general, a line from three to four and a half miles west of Cambrai.

The latest reports state that the British posted on the heights of Bourlon wood, in addition to repelling assaults, are shelling Cambrai furiously. As a German base and center of communication the town must henceforth be almost useless since the enemy is only three miles away. With the town as a target for the British artillery, either field guns or heavy guns, the system of railways centering there is practically lost to the Germans and the defensive line from Douai through Cambrai into Laon is seriously threatened. There are still some branch railroads east of Cambrai that can be used; but the main railroads under British fire can be used only at night. The Germans, however, may be able to get their vast supplies of war stores out of the city before it has to be abandoned; but, in the meantime, as any useful part of the defense line, Cambrai has ceased to be of importance. Recent reports give gains in the direction of Bourlon village despite strong opposition; it is evident the British will press the offensive to the east in order to control the base of the wedge of roads, both railroads and highways, that lead into Cambrai, now only three miles away.

It would appear that the offensive here, will be followed up by similar movements by both the British and French along many parts of the western front and that the winter season will see no halt in military operations; these will be carried out wherever possible. The pressure of the English upon the Ypres front is constant; and the combined Belgian, French and British pressure toward the Belgian coast is also increasing. It looks now as though, weather conditions permitting, a new and powerful effort will be made to force the Germans back from an extended section of the coast where the submarine bases are established. The successes around Cambrai will no doubt have an important bearing on the general plan of obtaining decisive results on the coast during the winter as foundations for more extended campaigns next year.

One part of the British lines has for some time been apparently undisturbed and out of the public eye; this is the German salient five or six miles deep around LaBassée from Armentières to Loos and Lens, a distance of 15 miles. If the British troops can make an extended drive here, it would bring their lines very close to Lille, the great German center for the front from the North Sea to Laon. A gain here would therefore be of immense strategical importance in forcing the Germans back to one of their prepared lines nearer Brussels.

While the battles around Cambrai have so profoundly affected public attention, it must not be forgotten that desperate fighting is also being carried on along the French front where a successful attack on the German lines was made in the Champagne resulting in the capture of some trenches and prisoners. North of the Chemin-des-Dames there have also been heavy artillery duels and some spirited engagements; in the Verdun sector the Germans have continued to bombard the French positions, especially around the Chaume wood to the east of the Meuse River.

In Italy the Italian armies have completed their reorganization after their disastrous retreat from the Isonzo and have withstood on the line of the Piave, but especially on the Monte Grappa and Asiago fronts to the north, the most determined assaults of the Austro-German forces. The latter have persisted for days in endeavoring to gain the summits of Monte Tomba and Monte Funera, which are foothills of the higher mountain; the latter has long been a barrier to the invasion of Italy from any part of the Trentino front. Heavy fighting has gone on here but the Austro-Germans have suffered staggering losses and have been successfully held in all the mountain regions around the headwaters of the Brenta and Piave Rivers. The 15-mile stretch between the two rivers has been the scene of bloody conflicts, but the defense of the line has been bravely and well conducted so that the Austro-German forces have been unable to make any progress. In fact, the Italian line resting on the foothills of Monte Grappa is holding firmly and the advance of the invaders appears to have been definitely checked. The morale of the Italians is improving day by day; in addition the arrival upon the northern front of both English and French reinforcements would appear to have given the necessary strength

(Concluded on page 465)

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Where Do We Stand In Optics?

To the Editor of the SCIENTIFIC AMERICAN:

Within the past year an Institute of Applied Optics has been established in France under the able directorship of Professor Charles Fabry, which is to include (1) a college of optics intended to provide a thorough theoretical training for opticians and at the same time to cultivate among its students a taste and zeal for optical research, (2) an optical laboratory for experimental and testing purposes, and (3) a trade school in optics with all the most modern methods and appliances. The courses of study are said to be already under way. The transactions of the institute will be published in a journal devoted to optical science. Meantime, a similar project has been inaugurated in England by the establishment of a Department of Technical Optics at the Imperial College of Science and Technology in London. Professor F. J. Cheshire, president of the Optical Society of Great Britain, who has had large experience in optical matters, has been appointed director, and the courses of lectures have been advertised for the current academic session. The British government and the London County Council have aided the enterprise with liberal grants.

It is not without significance that this long delayed step in both France and England is in reality a direct consequence of the war. The importance of properly organized manufacturers of optical glass and of optical instruments had been manifest, and the matter had been frequently and insistently brought to the attention of the governmental authorities, but until the dire necessities of war revealed the lack of optical preparedness little heed was paid to these representations. A writer in *Nature* (Vol. 99, August 2d, 1917, p. 448), commenting on the situation, observes feelingly that "the thought of what range finders mean to the British Navy and of how narrowly we escaped being dependent upon the enemy for our supply of these essential instruments, is almost enough to make one shudder even under the wings of a Royal Navy that has swept the sea." Some time ago a Board of Scientific Societies was organized in England by the Royal Society to investigate scientific and technological problems arising out of the war, and the first formal report to be issued by this body is entitled "National Instruction in Optics." The report which was published in full in *Nature*, March 1st, 1917, and which is well worth reading, emphasizes the necessity for immediate action and asserts that "the next few years are the years which will determine the future of the (optical) industries of the country."

It goes without saying that the same reasons which have led to the establishment of these optical schools in France and England are equally applicable in the United States. If the optical industries are to be encouraged and developed among us, not only now but in the years to come after the war, there will be an increasing need of trained and experienced men with a more or less extensive acquaintance with the whole range of optics, both theoretical and applied. At present there is no university in this country where this special training can be acquired. In our colleges optics is studied merely as a part of physics and by students who have little or no concern with the manifold applications of optics in the arts and industries of the modern world. Not many of us pause to think of the aid which optics lends to the prosecution of scientific research in all its branches or of its relation to the vital problems of human vision. In America as well as in England and in France optical science has had illustrious votaries whose work has become known all over the world; but notwithstanding, it has come to pass that the great domain of applied optics has in modern times become almost exclusively a German province, not because the Germans possessed superior skill and genius in optics, but because they realized the great practical importance and far-reaching influences of this territory and have assiduously cultivated it ever since the epoch of Fraunhofer, who is justly regarded in his own land as the father of scientific industry in Germany.

Already in the United States there are signs of an awakening to the needs of the situation. Under the auspices of the Optical Society of America a new scientific journal devoted exclusively to optical science in all its branches has recently made its appearance. This in itself is an achievement of good omen. Undoubtedly, there is growing up in this country a deeper appreciation of the desirability of closer coördination between science and industry. One of the lessons of the war—which would seem to be self-evident, but which needed to be driven home—is that the same science rules in the workshop as in the laboratory. This was the lesson that Fraunhofer taught his countrymen. Huxley said that what people call applied science is nothing but the application of pure science to particular problems.

Animated by such purposes and ideals and by the example of England and France, a scheme is on foot to establish in at least one of the largeAmerican universities courses of lectures and of laboratory training in the various branches of Applied Optics. It is proposed to include, for example, such studies as Geometrical and Physical Optics, Theory of Modern Optical Instruments, Lens Design and Lens Testing, Manufacture of Optical Glass, Refractometry, Polarimetry, Physiological Optics, Photometry and Illuminating Engineering, Interferometry, Spectrophotometry, Colorimetry, Optometry, etc. A certain portion of this work is already being done in Columbia University, and it is to be hoped that the authorities of that institution can be induced to undertake the larger programme indicated above. The graduate students would be recruited from various classes—army and navy officers, students or ex-students of the universities and technical colleges, astronomers, manufacturers of optical instruments, oculists, optometrists, etc. The ordinary period of study would probably be one year. Presumably, the courses could be so arranged that a student with the necessary qualifications could obtain the degree of Master of Arts.

It is desirable to ascertain in advance whether there will be a sufficient demand for "optical engineering" in this country, because obviously this will be the first question that will be asked by a university board of trustees. The college authorities will wish to know how this project is viewed by the leaders of the optical industries themselves. It would seem that financial support ought not to be lacking. At any rate the writer hopes that light will be shed on all these questions not only by discussion and suggestions in the columns of this paper but also by personal correspondence.

JAMES P. C. SOUTHALL.

Department of Physics,
Columbia University.

The Submarine Not Settled

To the Editor of the SCIENTIFIC AMERICAN:

I am rather impressed with the idea that there appears to be laxity now on the part of the country generally toward preparing further for the submarine menace, the authorities evidently believing that the German effort has largely spent itself, or that our allied combined fleets can meet the necessities. I do not fully agree with this but think that we should utilize the present time to prepare for some new phase or even greater menace in this direction. Germany has knowledge of our doings, but we do not seem able to keep so well posted in advance of her plans; I am sure, however, that we can count well upon the point that she has not abandoned the submarine to a secondary position. It will come forward soon in more formidable force, and perhaps in a more extended field of operation. She has to train new crews, and finish up perhaps a larger number of super-submarines, and perhaps has decided not to make the former mistake of launching them as they are ready and equipped as heretofore. She would do well to have all understand that it is a failure, more or less, and then suddenly to launch a much larger and more formidable force than ever. That was her mistake before; she will not make it again. Apparently they are preparing; we are dilatory about taking every possible precaution. Her spies and intriguers in high places, keep her posted, while we cannot get even a hint of her plans. But we know what her necessities are and we know she cannot afford to abate the submarine efforts, but must extend them, profiting by past experience.

JULIUS S. PRICE.

San Francisco, Cal.

Better Vaporization

To the Editor of the SCIENTIFIC AMERICAN:

The writer is a constant reader of your valued paper, and has noted with much interest the moves that you have made toward arousing the interest of the public in conserving the supplies of the Nation that are most essential to its life, especially during the period of the war. In this connection I have noticed that there has been comparatively little said concerning the fuel situation, and especially the gasoline situation.

You are, of course, well aware that gasoline is one of the vital factors in this war and if press reports are true the situation is growing worse and worse every day, with regards to its increased use, and the inability of the producers to keep pace with the demand, which grows daily. What will be the ultimate outcome of such a situation? It is a self-evident fact that something will have to be done.

The increased demand and the limited supply have forced the producers to market a grade of gasoline that is of a lower grade than has ever been offered to the public under the name of gasoline. To meet this condition the manufacturers of several automobiles have resorted to the final solution of the problem—the application of more heat and a consequent better vaporization of the fuel. Those manufacturers who have cast their intake and exhaust manifold in one piece, have been able to take care of this condition, very well indeed, as the hot exhaust heats the intake section and allows a condition that can not be obtained where the manifolds are separate.

Such arrangement will completely vaporize a very low grade fuel with perfect satisfaction. This also gives the car-owner better mileage, and ought to be the standard method of manufacture as long as the gasoline situation continues as it is.

If you would endorse such a move, or recommend that devices that produce more heat be used, it would it would do much to relieve the situation—especially when the weather gets colder.

ROY LITSEY.

Dallas, Texas.

A Substitute for the Big Gun

To the Editor of the SCIENTIFIC AMERICAN:

If the following idea could be perfected, I think that it would make large cannon a thing of the past:

Construct the cheapest kind of aeroplane. Have the motor in the same of the cheapest type capable of carrying the machine only 30 or 40 miles. Instead of carrying a human being, have it carry a large and highly explosive bomb. These machines could be started and timed so that they would come down at a given point 40 miles away and explode. By experimenting with these for a short time it seems as if they could be made very effective and outrange the largest guns. The cost of construction would not be any more than firing a large piece of artillery.

ALLEN M. CULVER.

Los Angeles, Cal.

A Reward for Submarines

To the Editor of the SCIENTIFIC AMERICAN:

Now that the United States are our Allies, I think some wealthy American might adopt the same policy as regards sighting enemy submarines as has been done in this country with undoubted success.

In the London *Times* of March 1st, 1917, appeared the following notice signed "A. F. Yarrow."

"It goes without saying that it is of the utmost importance to sight a submarine at the earliest possible moment. To encourage every one to keep a sharp lookout, I beg to offer a reward of £20 (up to a total expenditure of £10,000) to anyone on board a commercial vessel who first draws the captain's attention to an enemy submarine in the vicinity.

"The reward will be paid on a certificate from the captain giving the name of the person who first draws his attention to an enemy submarine, and a statement signed by the captain saying that a submarine was actually sighted. The application should be forwarded through the owners to Sir Thomas L. Devitt, Bart., Chairman of Lloyds Register of Shipping, 71, Fenchurch-street, London, E. C., who has kindly consented to make the awards."

It is self-evident it is a most important thing to sight an enemy submarine at the earliest possible moment, so that steps may be taken, as far as possible, to avoid it.

FRANK STRATTON.

Hyde Park Hotel, Knightsbridge, London, S. W.

Horse-Power and Horses

To the Editor of the SCIENTIFIC AMERICAN:

I note in your issue of November 17th, 1917, Mr. John Q. Everson gives a very interesting illustration of the length a team of horses would have to be to exert 185,000 horse-power, the power used in a vessel described in your previous issue.

Mr. Everson has made a very usual error in comparing mechanical horse-power with the actual animal horse-power. Watts' estimate of 33,000 feet pounds per minute was based on the horse working 10 hours daily; hence we would have to have 140 per cent more than the 185,000, or 444,000 horses available to furnish our vessel with 185,000 horse-power continuously for a week or more. Should our horses weigh an average of 1,500 pounds each, we would be appalled by the fact that our vessel would have to have a capacity of 333,000 tons simply to carry our power equipment. Then should we add the additional thousands of tons of necessary feed we are driven to the conclusion that the ancient galley with its many banks of oars must of necessity have been a very inefficient device, particularly when we reflect that a galley to be equal in power to the steamship in question would have had to carry a complement of 4,444,000 rowers, working 10 hours in each 24.

When it is recalled that our Government is put to their wits end to transport to France 5,000,000 men in our army within a year, it will demonstrate that we have surely made progress in the last 2,000 years in generating power to propel a vessel efficiently.

CHARLES A. WRIGHT.

Philadelphia, Pa.

The Military Decorations of Our Fighting Men

As They Are and As They May Be

By Albert A. Hopkins, Author of "Our Army—Our Navy, How to Know Them"

THE custom of awarding medals for military service is believed to have originated with those pioneer inventors, the Chinese, many centuries before the Christian era. The decorations of fighting men as a whole owe their origin to the badges which the armies of England wore in the transition between the decline of armor and the introduction of distinctive uniforms. Commanders rewarded their men for acts of extreme heroism upon the battlefield by giving them regimental badges struck in some valuable metal. The recipients removed the ordinary metal sign from their coat or hat, and substituted the much coveted emblem of bravery. Herein we have the source of medal granting and wearing, as it exists today in the armies in death grips on the battle lines of shell-torn Europe.

Queen Elizabeth struck the first war medals and they were very justly dispensed with a sparing hand, and for the Navy only. Charles I. struck the first military medal, while the credit of bestowing the first campaign award, that is to say when the whole army receives the token, was reserved for Oliver Cromwell. In later years arose the vicious custom of awarding the medals sometimes years after, and at the present moment there are hundreds of unclaimed medals lying at the British War Office and the Admiralty awaiting claimants. Latterly, however, the Allies have found that a decoration quickly bestowed is twice bestowed. Many of them have been pinned on the breasts of the heroes a few hours after action, and this is as it should be.

Roughly speaking a medal is a metal disk of gold, silver or bronze stamped with a design on the obverse or front face, while the reverse or under surface is usually given up to another design or some inscription often containing the name of the recipient. English war medals often have the names engraved on the edge. By "decoration" we are to understand an award in the shape of a star, cross, or some other non-circular form.

We have several problems before us. First, we are fighting interlocked with allies, so that acts of heroism are apt to occur at the same time with those of our companions in arms; and second our men receive the same citations and tangible awards for bravery as do the soldiers of France or Canada. Under the Constitution Americans fighting in our armies abroad cannot, without the consent of Congress, receive decorations which foreign governments have wished to bestow upon them. Fortunately this anomalous condition will doubtless soon be a thing of the past since several bills designed to remedy it are pending before both Houses. It has been found that the morale of armies is so improved by the proper distribution of honors that the fighting forces have attained a higher degree of valor since greater attention has been paid to the prompt award of medals and decorations. The Prussian "Iron Cross" has been turned out by the hundreds of thousands and is worn by those who have never been within three hundred miles of a military front. Of course decorations of this kind are practically worthless and do not come within the purview of our remarks.

The stress of war and the press of war measures in Congress during 1917 left no time for any member of that body to think long and well upon the subject of war-honors for war heroes. Every patriotic thought and act was centered upon the mobilization of men, money and materials, and dispatching each to its own place. A short time ago a private citizen launched in a New York paper a well-thought-out campaign for the founding of a comprehensive system of war honors and their bestowal upon our own men. A few days later it was put in the hands of every member of Congress, and on October 4th Representative Murray Hulbert introduced at the request of Dr. William T. Hornaday, Director of the New York Zoological Park, House Bill No. 6447, "To provide and award honor medals and other tokens for valor for distinguished services to the United States."

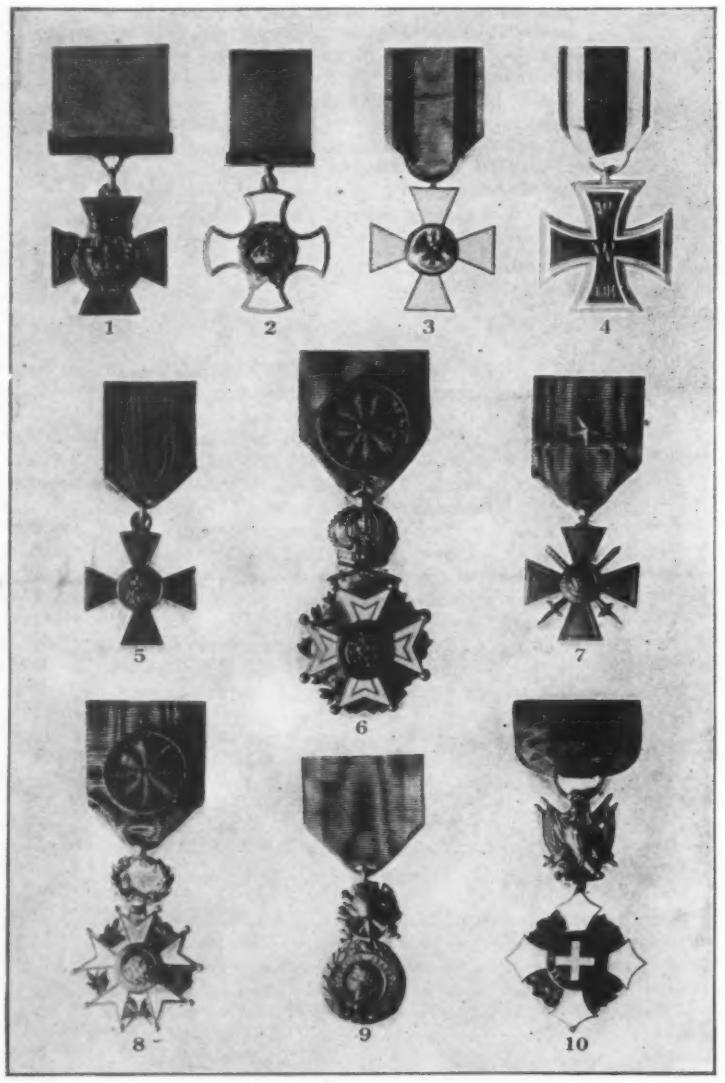
The foundation proposed by the Hulbert bill is the acme of simplicity and directness. It provides for the creation, by a brief and clear-cut act of Congress, of an Honor Commission, wisely chosen to consist of the Secretaries of State, War and Navy, the president of the National Academy of Design, the Director of the Mint and one distinguished citizen to be appointed by the President. The civilian members of the Commission are to serve without salaries. For the expenses of the Commssion, $5,000 are provided, and a like sum to cover the cost of the fabrication of insignia by the U. S. Mint.

The Honor Commission is to be empowered to do everything necessary to provide honors and their insignia, and to establish regulations for their award. The scope of the foundation is to be so broad that it will cover the duty of the nation to officers and men of the Army, Navy, Marine Corps, the Hospital Service and also private individuals who render distinguished services to the Government. It also provides that every person who since August 1st, 1914, has received or in future may receive a decoration from a foreign allied nation for gallantry or meritorious services may accept it and wear it, although the Lodge bill will probably make this section unnecessary. One of the greatest merits of the Hulbert bill is the celerity with which its provisions can be carried into effect. It contemplates as extensive and satisfactory a series of war honors as now are given by England or France, and just as great promptness in their bestowal after they have been earned.

There are now several other war-honor bills before the House of Representatives. One is the Lodge bill, providing for the acceptance of foreign decorations by Americans in the Army or Navy; and that bill should be passed, immediately. Another is so hastily drawn that it provides *only for the army;* and the Secretary of the Navy never heard of this bill or its defects until it had passed the Senate and been favorably reported by the House Committee on Military Affairs. Then Secretary Daniels requested that the men of the Navy should participate in its benefits, and now there is talk of amending it. But it is impossible so to amend it as to produce the broad and liberal measure that is demanded This bill (S. 1730) should be recalled, at once, by the House Committee on Military Affairs, and the Hulbert bill should be substituted for it.

The American Numismatic Society has an unrivalled collection of medals and decorations of all periods and therefore it would seem logical that they should sponsor an activity of this kind. The whole resources of the organization have been thrown into the scale in an effort to secure results which will compare favorably with the honors of our Allies. The House Committee on Military Affairs has been asked to hold at the earliest possible moment a hearing on the Hulbert bill, and when that occasion arrives it is reasonably certain that it will be seized upon by a large number of patriotic organizations and individuals as an opportunity to register their long-standing desire for justice to our men in khaki and in blue in the matter of war honors. The present medals of the United States are inadequate and the machinery for their bestowal is as antiquated as the horse car. We are confronted with the greatest emergency not of modern times but of all times. Why neglect an inexpensive and easily adopted minor accessory to military success if not to military decision?

To illustrate what other nations are doing, and doing now, we show ten decorations of the leading nations at war, taken from the cabinets of the American Numismatic Society in New York. A glance at them will show why it is good business to bestow equivalent honors upon worthy cases of heroism on land and sea.



Military decorations of the warring nations

1. Great Britain—Victoria Cross, bronze; ribbon, red for the army, blue for the navy. 2. Great Britain—Distinguished Service Order, enamel; ribbon, red, blue stripes. 3. Prussia—Order of the Red Eagle, enamel; ribbon, white, yellow stripes. 4. Prussia—Iron Cross, iron and silver; ribbon, black, white stripes. 5. Russia—Order of St. George, enamel or silver; ribbon, black and orange stripes. 6. Belgium—Order of Leopold, gold and enamel; ribbon, maroon. 7. France—Croix de Guerre, bronze; ribbon, green and red stripes. 8. France—Legion of Honor, gold and enamel; ribbon, red. 9. France—Medaille Militaire, gold and enamel; ribbon, yellow and green stripes. 10. Italy—Order of Savoy, gold and enamel; ribbon, red and blue stripes.

Save Coal and Help Win the War

CARELESS use of coal in stoves and furnaces during the war is an economic crime. Be sure the heat is doing what you want it to do rather than needessly heating unoccupied spaces and the chimney. Weather strips, double windows, pipe covering, heating drums in stove pipe and extra radiators pay. It is cheaper to use a larger radiator in the always chilly room or in the room to be kept specially warm than to force the fire. Do not let the house get too warm.

Open fire places are inefficient. Use them sparingly. Let heat from the kitchen stove remove the chill of the house as long in the season as possible.

When stoves or furnaces must be started, see that smoke passages and chimney are clean and are kept clean.

Air above the fire must come in only through dampers, usually in the door. All other openings for such air must be closed.

Study the directions for running your furnace. If you do not have directions, send to the maker of the furnace for them.

Keep ashes cleaned from under the grate. The fire burns more uniformly and with less clinker with a clean ash pit.

It is best to keep a full fire pot, level with the bottom of the firing door. If the draft is poor or the coal fine, thinner fires must be kept. In mild weather the fire can be carried thinner by allowing a few inches of ashes on the grate. In cold weather keep the grate free of ash.

Attend the furnace at regular periods. Anticipate the demand for heat. Rapid pushing or retarding of the fire is uneconomical.

If soft coal is used, break the lumps to fist size and do not cover the whole surface with fresh fuel. Leave a bright spot to ignite gases.

Small charges of coal frequently applied are more economical than infrequent firing, but the fire bed should be disturbed as little as possible by shaking and poking. Convenience usually determines periods of firing. Shaking and cleaning the grate twice a day is usually enough. Stop shaking as soon as it begins to be bright under the grate.

If the fire gets very low, open the ashpit damper and add a little coal not too fine. Do not disturb the grate or ashes. When the fresh coal is well ignited, shake the grate and add more.

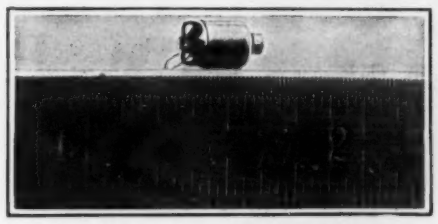
A fresh fire or a large fire requires air over the fuel bed as well as through it. The damper in the door is for this purpose.

To check a fire close the ash-pit door and open the check draft in the smoke pipe.

The main damper in the smoke pipe should be partly closed if the draft is so strong as to make checking and control of the fire difficult with the check draft.

Smallest Motor in the World

A JEWELER of Hillsboro, North Dakota, has recently constructed a motor, said to be the smallest in the world. The motor, just a fraction over a quarter of an inch long, is perfect in every way, and contains everything found in larger motors. The commutator has four segments made of gold, each segment being insulated from the other with mica. Fiber is used as insulation between commutator and shaft; also between the end pieces and commutator. The commutator is built up in the same way as the ones on the large machines, no glue or cement being used in its construction. The commutator is 0.045 inch in diameter, and is mounted on pivot steel shaft 0.009 inch in diameter. The armature has four poles and is wound with No. 40 silk covered wire. Its diameter is 0.09 inch. The brushes are made of silver and are 0.12 inches in diameter. The springs for the brushes are 0.004 inches in diameter. The motor has two field coils between the armature and yoke. The length of the entire motor is 19-64 inches and its height 11-64 inches. It weighs 5½ grains. A small flashlight battery is used to supply its current.



A motor barely a quarter-inch long

Riding a Moose

THE most remarkable feat performed by a man with a wild animal in the open as an unwilling partner is the unique act which happened recently in Ontario, when a hunter rode a wild moose. The accompanying pictures tell the story of the most exciting moments of the chase.

The fondness of moose for water and their great swimming abilities is well known. Rainy Lake, Ontario, Canada is in a region abounding with moose and other game and has only been recently made easily accessible to the sportsman by the completion of the Canadian Northern's new transcontinental railway. It is not an uncommon sight to see the animals swimming across the lake.

All aboard for the shore

A strange mount

When one was well out in the middle the two sportsmen overtook it in their canoe by paddling out from a point and cutting it off. Running the canoe alongside the swimming animal, the man in the bow let himself over the side of the boat, maintaining his own balance and keeping the canoe steady by placing his feet on the moose's back. The whole required cool nerve and a long knowledge of boating for the canoe is the most unstable of all craft. When the right moment in his judgment had arrived he threw himself clear and down onto the animal's back in a true riding position. Holding on with one hand to one of the submerged points of the antlers at the rear he maintained his position, while waving his hat to urge the moose on to its best efforts as his novel steed proceeded shoreward with its unaccustomed burden.

But their danger was, once the moose got ashore he might turn on his rider, so when nearing it, the man slipped off and climbed back into his canoe, allowing the moose to make good its escape, none the worse for its experience.

Curious Sparrow Trap

IT is a commonplace that birds are voracious eaters, frequently devouring more than their own weight of food in a day. While this apparent greediness is due merely to the fact that in proportion to their weight birds are called upon to produce an extraordinary amount of energy, it is difficult to restrain oneself from taking the highly moral attitude toward the victim of the accident illustrated herewith, and considering him as having met the just reward of gluttony.

It will be observed that this sparrow has eaten his way clear through a large breakfast roll, and out on the other side, only to find at the last moment, when his voracious bill has demolished everything within reach, that he is stuck in a straightjacket of his own making, and can neither proceed nor back out. We have seen sparrows trapped in drains and leaders and even in the open space between floor and ceiling, into which it had squeezed through a cranny in the shingled outer wall of a suburban cottage; but we never before saw a sparrow trapped in a crust of bread.

A sparrow trapped in a breakfast roll

Japanese Aeroplane Motor Contest

THE Imperial Aviation Association of Japan, realizing the backwardness of the Japanese people in taking up aviation, and appreciating the necessity of encouraging the building of aeroplane motors within the country itself, some time ago decided to hold a prize contest for motors designed and built by Japanese. There were to be three prizes, of $10,000, $5,000 and $2,000, respectively, for the motors attaining the highest average marks. The grading was done according to a system which included the number of hours the motor would run effectively, the weight per horse-power, the number of revolutions per minute, the net horse-power developed at the propeller shaft, the fuel and lubricating oil consumption, and the proportion of imported parts used on the motor. The committee which judged the motors was composed of professors from various technical schools, officers of the army and navy, and others. The contest was held on June 22d, last, at Tokorozawa, the aviation field near Tokyo.

Twenty-two inventors had signified their intention to enter the contest, states *Industrial Japan*, but at the time set only three entrants with four motors presented themselves. Two others, too late to enter into the official competition for the prizes, had their motors examined by the judges, but results were not recorded. The four motors officially examined were as follows:

Name of Inventor	Kisui	Shimadzu	Shimadzu	Asahina
Cycles	4	4	4	4
Cooling Method	Air	Air	Air	Air
Number of Cylinders	8	9	8	9
Bore	3.77 in	4.13 in	4.5 in	4.5 in
Stroke	4.72 in	5.51 in	4.5 in	5 in
Horse-power	70	80	90	100
Type	V	Rotary	V	Rotary
Revolutions per Minute	1400	1200	1800	1100
Weight (pounds)	455.4	298	496.8	414

The motors were examined on the testing blocks. None of them except Mr. Shimadzu's rotary 9-cylinder engine achieved any large measure of success. Mr. Kishi's air-cooled V-type motor did not fulfill the expectations of the judges, owing to minor defects. This motor was able to run effectively for 1 hour and 19 minutes, but at no time developed more than 4.51 brake-horse-power, although the indicated horse-power was 70. The failure of the motor seemed to be due to faulty adjustment rather than to poor construction.

Mr. Asahina's motor was of an original design and showed evidences of careful planning, but the selection of the materials and the proportion of the parts demonstrated that the whole motor was of amateurish construction. The motor ran for 1 minute and 27 seconds, and at no time developed more than 76.5 horse-power, although it was rated at 100 horse-power. The stoppage was due to the breaking of one of the parts.

Mr. Shimadzu's 90 horse-power 8-cylinder V-type engine suffered a like fate. Up to the moment when it broke down, the motor ran only 2 minutes and 20 seconds, developing an average of 34.3 horse-power at 7.70 revolutions per minute.

The only really successful motor in the contest, and the one which won the first prize of $10,000, was Mr. Shimadzu's 9-cylinder rotary engine. This motor is said to be a close copy of the Gnome engine. It ran for 4 hours and 3 minutes, but as the revolutions and horse-power developed during the last 7 minutes fell considerably below the average, the time of effective running was 3 hours and 57 minutes. The slowing down during the last 7 minutes and the final stopping of the engine were due to misfiring caused by carbon deposits in the cylinders.

The horse-power and the speed of the Shimadzu rotary engine were fairly steady throughout the time of effective running. The greatest horse-power developed was 74.6 and the lowest 58.6, while the revolutions per minute varied only from 1140 to 1020. The fuel consumption appears to have been very high, and the reports place it at 112 gallons for the 4 hours and 3 minutes of running, or at the rate of 43 gallons per horse-power-hour.

It is understood at present that Mr. Shimadzu intends to use the prize money to study aeroplane motors in America.

The Tomono engine was finished too late to enter the contest, but was unofficially tested by the committee. No results of the test were published, however. The specifications of this motor are as follows:

Inventor, Tomono Naoji; cycles, 4; cooling, water; cylinders, 6; bore, 4½ inches; stroke, 4.375 inches; weight, 397 pounds; horse-power, 90; revolutions per minute, 1200; type, vertical.

Strange Converter Explosions

SOME unusual explosions are occurring in converter steel foundries in Germany, according to *Stahl und Eisen*, the German trade and technical paper. A small converter is used in such foundries, having a capacity of two to three tons, and used for making steel castings.

The explosions generally occur with over-blown charges. The writer mentions a recent case in his own experience. A charge was finished in about eight minutes, but as the metal was too sluggish for teeming, the shop manager decided to continue the blowing. The after-blow having lasted four minutes, the characteristically green flame, with small illuminating power, made its appearance and small pellets of slag began to spatter out. The converter was then turned down and the finishing iron added, when in about fifteen seconds the charge began to burst into flames, at first slowly, then more rapidly, and a series of small explosions took place, which scattered lumps of slag to a distance of over thirty yards. The explosions, according to the writer, are the more violent the more the charge has been over-blown, and he thinks the behavior of the metal is due to the well-known reaction of the ferrosulfuric oxide in the slag upon the carbon in the finishing iron.

New Steam Motor Truck

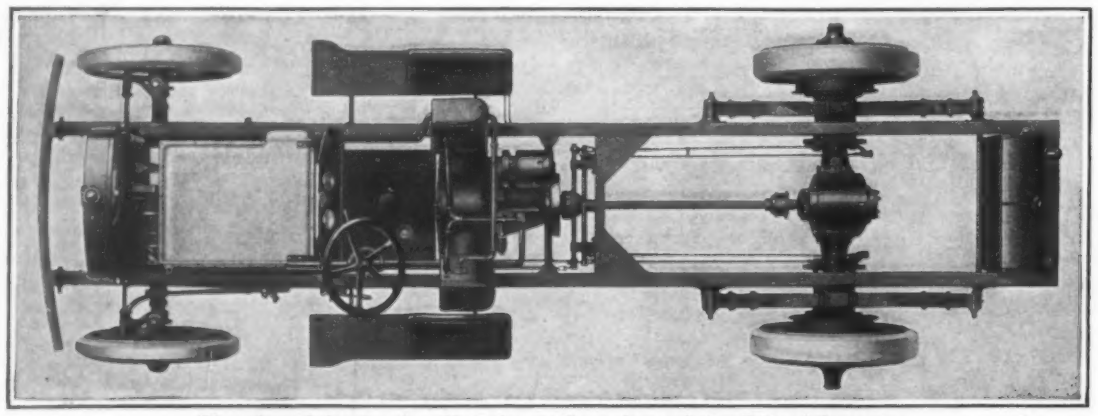
The Advantages of an Even Torque for Heavy Hauling

THE application of the steam motor to heavy hauling by motor trucks, as described in the following article, will command the attention of those who were interested in the article on the Doble Steam Car, which was printed last year in our issue of December 23d, 1916.

The results obtained with that car were so favorable as to justify the development of a motor truck employing the same plant, with such modifications as were necessary to meet the special conditions of motor-truck service.

By the courtesy of the designer, Mr. Abner Doble, we are able to give the first presentation of the drawings of the truck, with a brief description of its salient features.

When the plans of the steam car were first brought to our attention, we asked the designer what was the inspiration which gave him courage to spend his time and resources upon a type of car which one of the largest of the automobile companies, after years of exploitation, had abandoned in favor of the all-but-universal gas-operated type. He said that the basis of his faith was the inherent and universally-acknowledged excellence of steam as a motive power. On this as a foundation, he set out to design a motor which would eliminate the defects which had caused the all-but-universal abandonment of steam, and in doing so he decided to apply to the new design, as far as might be possible, certain excellent features of automobile gas engine practice. Among the defects of the old steam car to be eliminated were the delay due to getting the fire started; the difficulty in conserving the water supply because of incomplete condensation, resulting in a very limited radius of action due to loss of water; and, finally, the trouble due to scale in the boiler.



Plan view of the chassis. Note the small number and simplicity of the parts

The delay in starting the steam car was remedied by substituting for the old and clumsy torch a special feed nozzle and utilising the familiar spark plug of the gas car for instant ignition.

Complete condensation of the water was obtained by taking over bodily the gas car radiator with its large cooling surface, which proved to be so efficient that the radius of 80 to 100 miles on one filling of the boiler in the old steam car was extended to several hundred miles.

Scale in the boiler was eliminated by the novel expedient of introducing the cylinder lubricating oil into the tank and causing it to pass through the boiler and the cylinders, thereby preventing scale in the one and providing lubrication in the others.

The Boiler

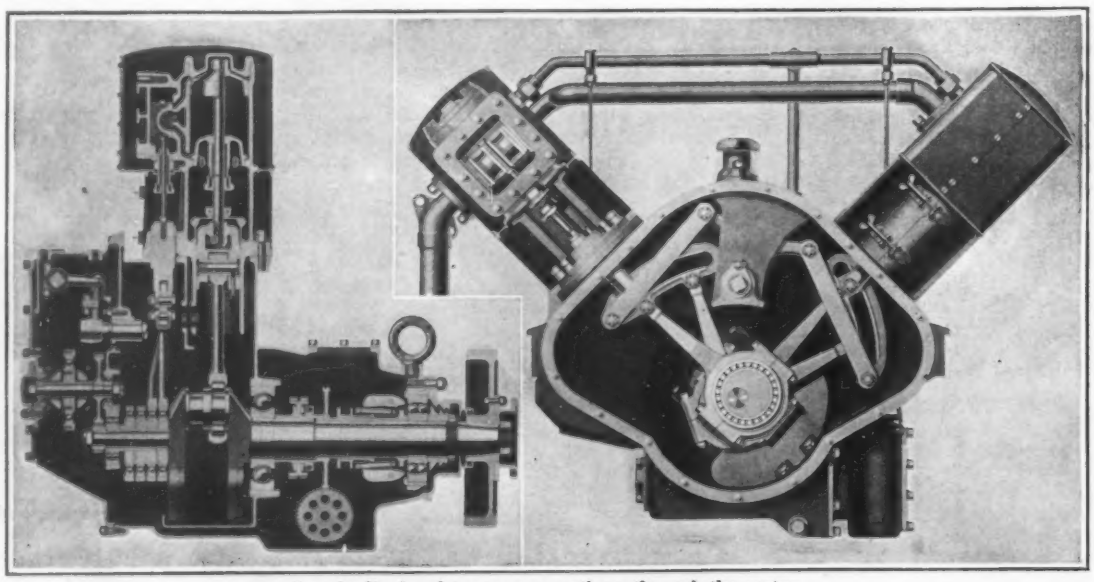
The boiler or generator is made up of 20 similar sections, placed vertically side by side; and each section consists of a top and bottom horizontal header connected by 20 vertical tubes. These are three-quarters of an inch in diameter and made of cold-drawn, seamless steel tubing. The tubes are swaged at the top and the bottom to about three-eighths of an inch, and they are welded to the headers by the autogenous acetylene process. It will thus be seen that each section is practically a single piece of steel—the welded joints being, if anything, stronger than the tubing itself. Adjoining the generator proper and separated therefrom by a vertical wall of refractory material, is the economizer section, which is shown to the right in the accompanying sectional view of the boiler. The economizer consists of six sections of similar construction, each section containing 16 vertical tubes.

The combustion chamber, made of a heavy refractory material, is placed immediately below the steam generating section, while below the economizer sections is an exhaust pipe available for carrying off the products of combustion.

The feed water, forced in by a plunger pump, is delivered to the lower headers of the economizer sections. These are completely filled; from them the water overflows from their upper headers into a manifold, from which it is led to the lower headers of the evaporating sections, which are filled to about one-half their height. The water is maintained at this level by means of a by-pass valve, which so operates that when the regulator tube is filled with steam and is hot, the by-pass valve is closed, forcing the water from the pump to lift the check valve and enter the generator. As the water level rises, the regulator tube is filled with water from an exposed pipe, and since this water is cool, the relatively large change in temperature causes the regulator tube to contract, opens the by-pass valve, and causes the water to return to the supply tank.

After the hot gases have given up most of their heat in the generator section, they are passed over the bridge wall, and give up a large portion of their remaining heat units to the feed water which is flowing slowly up through the economizer

Each section of the generator is tested hydraulically to a pressure of 5,000 pounds, and the safety valve is set to operate at 1,000 pounds. The normal steam pressure, while the motor is in operation, is 600 pounds to the square inch. This pressure is maintained by an automatic device, which cuts off or turns on the blower according as the pressure varies above or below the normal.



Longitudinal and transverse sections through the motor

Conserving the Water Supply

We have spoken of the adoption, in this steam motor, of the gas engine raditaor with its large cooling surface. A radiator of the honey-comb type is used, which provides about six times the radiating surface that was commonly available in the earlier steam cars. In normal running, the condensation is perfect; but when accelerating rapidly from slow speed, or when moving slowly on a heavy road or up a steep hill, the steam will not all be condensed in the radiator, and some steam will pass with the condensed water to the water tank, which is placed just in front of the engine. In order to secure the condensation of this steam, the water of condensation is arranged to enter the tank near its bottom, and any steam that may find its way to the tank is condensed in bubbling up through the water. To guard against any accumulation of uncondensed steam, a vent is provided at the top of the water tank.

Anyone who operated a steam car in the earlier days of the industry will remember how limited was the range of the car due to loss of water, and how in a lengthy touring trip, it was necessary to keep a close watch on the water supply and look for a suitable stopping place to refill the tank. Actual tests have shown that the steam truck will run for several hundred miles on one filling of the tank.

Starting by the Electric Spark

Since, to enable the steam car to compete with the gas car, it was necessary to eliminate the unconscionable delay in starting, Mr. Doble resolved to do away at once with the old and altogether unsatisfactory torch. In its place, he substituted a starting and feed nozzle which is not shown in the accompanying illustration, in which air drawn through the radiator by an electrically driven blower, passes the spray nozzle with sufficient velocity to draw out the kerosene and atomize it. As the vent tube widens, the velocity of the air decreases: and, the fuel is ignited by means of the spark plug, which sparks when the blower is turned on. The burning of the fuel mixture takes place in a chamber made of a special refractory material, which reaches a very high temperature and insures complete combustion both by the high temperature of the gases and by its effective catalytic action. The flame is completely enclosed in the combustion chamber, and because of the perfect combustion secured, no soot is deposited on the generator tubing. So effective has the generator proved in over 60,000 miles in operation in a test steam car of this type, that sufficient steam for running may be generated from cold water in 1½ minutes, and if the water is still warm from a previous trip a start can be made in less than a minute. This is the case when the car has been used the previous night and is taken out during the next morning. Under these conditions it compares favorably with the gas car.

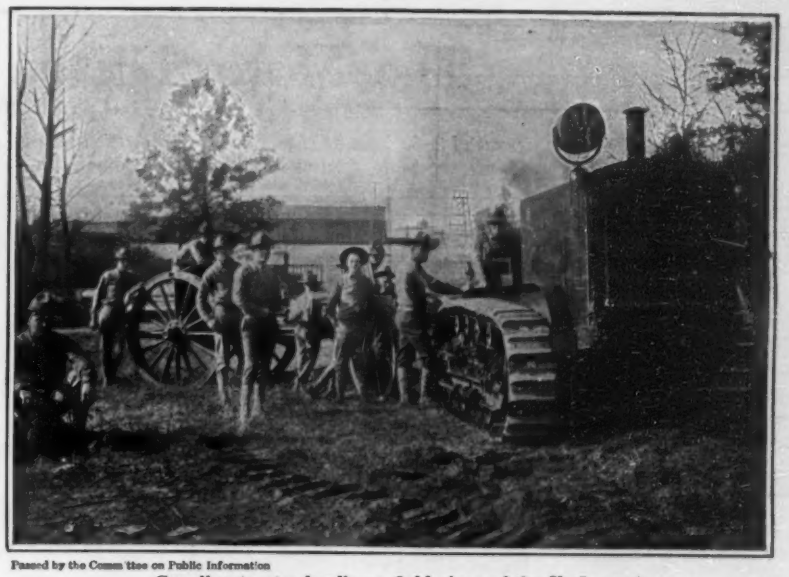
Lubricating the Engine and Boiler

One of the most striking features in this power plant is the means adopted for preventing scale in the boiler—that *bête noir* of the user of the early steam car. This is achieved by pumping into the generator with the water a small quantity of standard cylinder oil. The oil performs two valuable functions—first, it prevents scale, and secondly it passes with the steam through the throttle, the cylinder valves, and the cylinders, and thoroughly lubricates them. The oil forms an emulsion with the water and coats the interior of the tubes with a very thin film of oil; and because scale cannot adhere to a surface so coated, the interior of the generator is protected from accumulations of scale. Furthermore, as the particles of scale are precipitated they are coated with oil, and so rendered incapable of attaching themselves to one another. This practice has been found to be thoroughly efficient, no scale whatever being found in generators which have been in use for an extended period of time. The oil, furthermore, is carried with the steam through the throttle valve, and serves to lubricate thoroughly the valves and pistons. It will thus be seen that the lubricating oil, like the water supply, performs a continuous cycle, with the difference that there is practically no loss of the oil. It has been found

(*Concluded on page 465*)

Passed by the Committee on Public Information

Artillery tractor negotiating a steep hill under adverse conditions



Passed by the Committee on Public Information

Gasoline tractor hauling a field piece of the U. S. marines

Gasoline Horses Which Will Haul Our Artillery in the Field

HORSES which eat gasoline and lubricating oil instead of oats are to be used by our artillery in France. Instead of a string of spirited horses galloping at top speed over the battlefield with a field gun and caisson rolling behind, we shall have a less dramatic but far more efficient substitute in the form of a squatty, chugging tractor. This is but one more point in our claim that the American Army will be the best motorized organization in existence.

The two accompanying illustrations depict a type of tractor employed by the U. S. Marines for hauling their field guns. In general design this tractor appears to be much along the lines of the conventional agricultural tractor, with the power plant enclosed in a substantial hood at the front end and the driver sitting at the rear within ready reach of the various controls. The propulsion is furnished by a pair of huge, power-driven, caterpillar belts. One of the illustrations shows the tractor going up hill under the most adverse conditions, yet with apparently no undue effort; indeed, it is said of these artillery tractors that they will go anywhere a horse can go, and still farther.

The New Machine-Gun Carriage of Our Marines

AMONG the latest equipment of the United States Marines is a new type of machine-gun carriage which strongly suggests the little dog-drawn carts and machine guns used by the Belgians in the early days of the war, with such telling effect. But in the present instance the carriage is drawn by two men, and in this respect it more closely resemble the machine-gun carriages of the Russian troops.

Rapidity of motion is obviously the leading feature of the new carriage, for it is provided with two ball-bearing and rubber-tired wheels. A shaft, provided with a double handle, permits two men to pull the carriage, which mounts a Lewis machine gun. The ammunition drums are carried in square steel boxes, just below the gun. In order that the gun may be used to the best advantage, its mounting is such as to provide the utmost freedom of movement. In lightness and mobility this device speaks for itself.

Conscripting the Light-weight Automobile for Supply Railway Service

NOT contented with using thousands of lightweight American automobiles for ambulance service, our allies have now conscripted these machines for service on their supply railways. In the accompanying illustration, for instance, it will be noted that a well-known make of American automobile is being used as the power plant of an amumnition-train locomotive. The automobile, stripped of its wheels, is mounted on a four-wheeled truck. The usual drive is connected to the rear pair of wheels, and the brake system is connected with brake bands operating on drums fitted to the back axle. The body and the usual seats are taken off the automobile chassis and replaced by plain seats, built for service, so as to eliminate every pound of weight possible.

Despite the improvised appearance of the automobile-locomotive, it is proving most satisfactory in the supply railway service. We learn that hundreds of these grotesque locomotives are being used by the British and are living up to the reputation of their counterparts which are traveling over every road where an automobile is known.

Passed by the Committee on Public Information

A company of U. S. marines with their new Lewis machine-gun carriages in fighting trim

Passed by the Committee on Public Information

Mounted on a two-wheeled carriage, this Lewis machine-gun unit of the U. S. marines is highly mobile

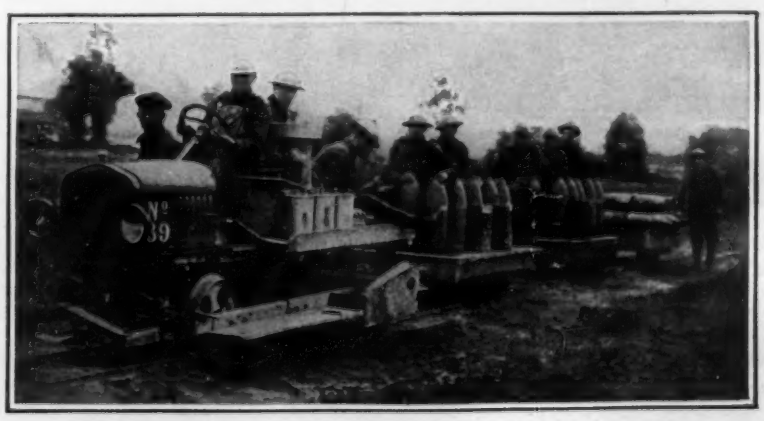
Japanese Paper Products

SOME time ago notices of a collapsible paper life-boat, the invention of a rear-admiral of the Japanese navy, appeared in several journals. This boat was said to weigh but a few pounds and could be folded up into a very small compass. Upon investigation some very interesting information regarding the paper used in the construction of this boat was secured.

The rear-admiral's invention consists, not of a new paper, but rather of a chemical process whereby a very tough fiber paper is rendered waterproof. This paper has been manufactured by the Japanese for centuries from the fiber of the mulberry tree. The paper is made up into any desired shape by cutting and cementing with an especially prepared adhesive; a lapped joint of one-eighth to five thirty-seconds of an inch has as much strength as the surrounding material. With the above mentioned adhesive any number of thicknesses can be cemented together and an almost unbelievable strength obtained. The paper is nearly as pliable as cloth and no amount of folding or crumpling seems to diminish its strength. A hole made in the body of the paper shows less tendency to enlarge than a similar hole in cloth. When desired the paper can be treated with an antiseptic which renders a sack made of this material capable of holding water continuously for several months.

Owing to lack of capital the admiral turned over his invention to a company which is at present engaged principally in making and testing out sample articles of this paper. There seems to be no limit to the different uses to which this paper can be put. Some time ago a sample sand-bag was submitted, upon request, to the British government; if this proves satisfactory, the company agrees to furnish the sacks at the rate of a million a month until the end of the war. These bags possess all the strength of canvass sacks, but unlike them they are waterproof, hence can be easily emptied, carried to an advance position, refilled and placed in any desired spot. The Russian government also has requested that a sample sand-bag be submitted for investigation.

Life-preservers, inner tubes for auto tires, bladders for foot-balls, air cushions, air mattresses, sacks for Portland cement, ponchos, "pup" tents, and moth proof bags for clothing are a few of the things that have been made and tested out, and as far as can be ascertained have proved successful. A life preserver capable of supporting a man indefinitely weighs but a pound and can be folded into less space than an ante-bellum Sunday newspaper. Cement sacks made of this paper are superior to anything now on the market, insuring the delivery of the contents in perfect condition. Sacks are now being supplied to a large cement manufacturer in the West. Goods that have heretofore been shipped in zinc lined cases can now be placed in a paper container just fitting the packing case, sealed with the proper adhesive, and shipped with as much safety as when the metal lining was used. Books bound in this paper are more durable than leather bound ones and can be made just as attractive as the paper can be beautifully embossed and colored. In short it seems possible to use this paper in a large per cent of the places where cloth and leather are now deemed indispensable. So to the once novel but now familiar idea of the paper car-wheel, it appears that we must add a vast range of other bizarre uses for paper.



Bringing up shells for British guns with an automobile-locomotive

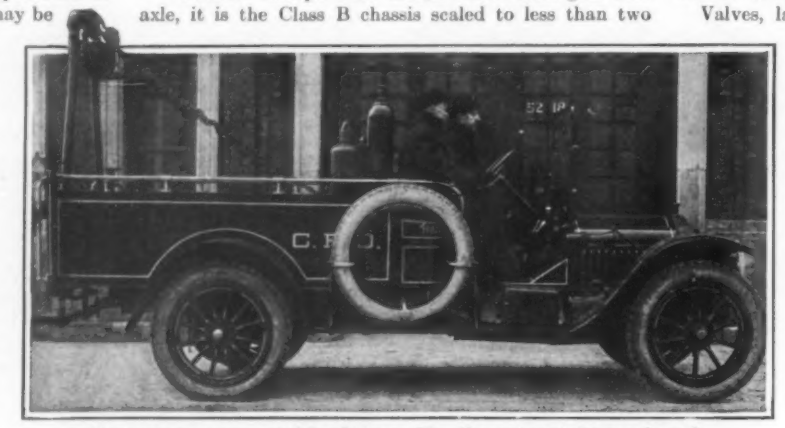
The Motor-Driven Commercial Vehicle

Conducted by VICTOR W. PAGÉ, M.S.A.E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Emergency Truck for Fire Department

THE Chicago Fire Department is using a new type of emergency truck equipped for the specialized work of making repairs to apparatus actually in service at fires. Since its installation, six months ago, the truck has been available twenty-four hours a day and three crews of men have been employed to operate it. Pieces of fire apparatus which break down or become damaged when responding to alarms are quickly repaired or towed to the shops, and sufficient equipment is provided so that wreckage and obstructions of all kinds may be quickly cleared up. A chain hoist is attached to the rear of the truck frame, this being supported by a substantial crane member. In the body of the truck, jacks are carried which are capable of raising twenty tons. A special towing attachment, having a coil spring drawbar, makes it easy for this comparatively small truck to pull heavy apparatus, such as pumping engines or hook and ladder trucks. Compartments are provided along the body side to carry tools of every description, one of the compartments having a strong cover which can be used as a bench top and to which a heavy vise is fastened. A complete oxy-acetylene welding outfit is carried so that broken parts may be welded or steel bars, plates, and structural iron work cut easily and quickly by the oxy-acetylene flame that could not be cut with ordinary tools. This part of the equipment is of great value in clearing wreckage containing structural steel work. The complete mechanical equipment is supplemented by a crew of expert mechanics especially trained in emergency repair work.

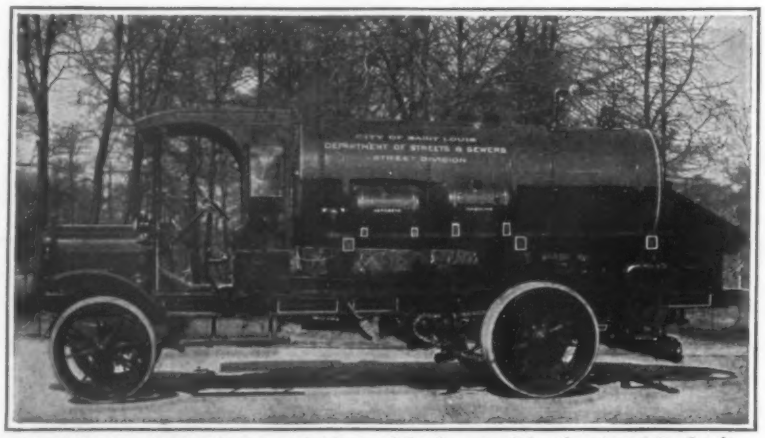


Emergency wagon used by Chicago Fire Department for repair and wrecking purposes

Combination Tank Truck for Road Maintenance

THE City of St. Louis has had a combination tank wagon in operation for some time that combines the function of a road oiler, a hot penetration tar spreader, a pressure flusher and a street sprinkler. Among the features of the new truck, which is mounted on a standard 5-ton chain-drive chassis, are a heating system to keep oil or tar hot and a rotary displacement pump to insure positive movement of the viscous fluids. The tank may be filled from the top with either oil or water, or the pump may be employed for drawing the oil from tank cars which can be on the same level as the truck. In order to secure a uniform distribution of heavy bodied oil or tar a heating system is provided, which will raise the temperature of a tank full of that material at the rate of one degree per minute and which will maintain a temperature of 350 degrees. The tank mounted on the 5-ton chassis will hold 1,000 gallons and is made of heavy steel, hot riveted and thoroughly calked, both inside and out. The tank is 4 feet in diameter and 10 feet 6 inches in length.

Sixteen distribution nozzles are located at the rear end of the truck and may be operated by a man sitting on a small seat on the right rear end of the truck frame. The distributing nozzles will cover a strip of road 8 feet 6 inches in width, and it is possible to move them to the right or left of the center for a distance of 24 inches by using a hand-wheel provided for the purpose. The nozzles are designed to throw a spreading or fan-like stream and are so set that one stream will overlap the other to make for uniform distribution. The pump exerts a pressure of 80 pounds so that the liquid issues with sufficient force to flow into all the crevices in the road. Various nozzles are furnished for different grades of oil. The operator of the nozzles at the rear of the truck can communicate with the truck driver by a double bell system, while the truck is in motion. A pressure gage and a thermometer for the heating system are mounted so that the operator on the rear seat can regulate both the pressure and the temperature to suit varying conditions. After the tank has been used for oil or tar it can be cleaned out by circulating kerosene through it with the pump, and it can then be used for water. When used for flushing, the pump has a capacity of 300 gallons of water per minute and covers a strip of road 12 feet wide. The sprinkling nozzles cover from 20 feet to 40 feet of road width.



Combination oil distributor, sprinkler and flusher, used by the city of St. Louis

Operator's seat at the rear of the liquid asphalt distributor

The Class A Liberty Truck

THE class A military truck differs little from the larger model. Except that it has an internal-gear rear axle, it is the Class B chassis scaled to less than two thirds the weight. Orders for three experimental chassis were placed on November 17th, to be completed December 10th.

The engine is now being tested in Detroit. Because of difference in size only a few parts of the class B engine could be used, so a complete new set of drawings, new dies and new patterns had to be made. From the start of the work until the engine was turned in, exactly 16 days and 20 hours elapsed. Both power and torque rank this motor with the class B as a highly successful product. At the governed speed of 1,200 revolutions per minute, 42½ horse-power is developed, and at 900 revolutions, the torque reaches its maximum of 198 pound-feet.

The cylinder is 4¼ by 5½ inches with 312 cubic inches displacement. The engine differs from that of class B mainly in that the four cylinders are in one block and that it has mushroom instead of roller type tappets. Two detachable cylinder heads cover two cylinders each, exactly like the class B except for size. This division of the head casting into two, makes the heads easier to handle when carbon scraping is necessary.

Valves, large in proportion to cylinder bore, are 1⅞ across the port. The exhaust opens 45 degrees early and closes 5 degrees late, while the intake opens 15 degrees late, and closes 38 degrees late. The lift is $\frac{5}{16}$ inch for both sets of valves.

The manifold layout and the accessories, ignition and generator, as well as the method of mounting in the frame, are like class B. The crankshaft, 2¼ inches diameter throughout, has three bearings, like the larger job. A slight point of difference, due to the block cylinder casting, is that the water pump delivers to a single opening instead of to two on the cylinders and the fan bracket is attached to the cylinder block instead of the crankcase.

Cooling is varied to suit the smaller engine by cutting down the altitude of the radiator by 4½ inches, using the same top and bottom cast tanks. The reduced length and height give the front of the truck a very compact look.

The clutch takes class B disks, only 14 surfaces as against 18 in the larger truck. It is inclosed in the same way, and the gear control with the brake lever which mounts on the bell housing is identical with the class B part.

The four-speed transmission looks much like that of class B; it is hung in the frame the same way with a slight difference. The back end of the aluminum case is machined on a circle like the face of a bell housing, and a steel forged ring is bolted thereto. On this forging are the lugs through which the frame attachment bolts pass, and the transmission brake anchors. This clever design insures absolute concentricity between brake and drum while no braking stresses can possibly be put upon the transmission case, since they pass directly from the brake shoes to the frame via the steel ring. The brake is very powerful, 7 inches diameter and 6 inches wide. It has two external shoes, contracted by a cam action, easy to remove for relining and equally easy to adjust for wear. Between transmission and engine a universal shaft is slightly inclined and the transmission is tilted to correspond, dividing the angularity between the two joints in front of the transmission and the two back of it in equal ratio.

The internal-gear-driven rear axle is new in design. It is not heavy and the brakes are completely protected from lubricant that might escape from the gear, while the accessibility of its details is remarkable.

The weight carrying member is a pressed steel "banjo" with steel tubes forced into the ends, very much like the regular passenger-car axle. Steel spring tables are rigidity attached at each end, carrying the driving pinion bearings and the brake anchorage.

The differential is carried in a steel casting inserted from the front of the pressed steel part, holding the bevel pinion and all the bearings. A light cover, removable from the back, incloses the whole assembly. The differential can be removed without disturbing the bevel pinion, or the whole can be taken out from the front without tearing down the entire axle. After taking off the wheels, drive-shafts can be withdrawn, as they fit into the differential on splines.

Grease is kept from the brakes by neat designing. The hub casting has bolted to it both ring gear

(Concluded on page 466)

TORBENSEN INTERNAL GEAR TRUCK DRIVE

HERE is a typical Torbensen-equipped truck-chassis "opened up" to show what a sensible, straight-from-the-shoulder drive it is.

How it Transmits the Power

The rear axle—which actually *drives* the truck—can never get *all* the power the motor develops. This is a well-known fact.

Therefore it's up to the rear axle to transmit to the rear wheels every possible ounce of the power it *does* get.

In Torbensen drive the power reaches the jackshaft in practically the same way as in other drives. But here's the difference—the jackshaft, by means of pinions fastened to its ends, drives internal gears, fastened to the wheels. This gives great driving leverage by putting the big gear reduction *on* the wheel and near the rim. This makes Torbensen-equipped trucks very powerful, even if they have small motors. The illustration shows clearly how simple and effective a drive this is.

TORBENSEN Drive is made to last. Every owner gets a GOLD BOND GUARANTEE that the I-Beam axle and spindles will last as long as the truck, and the internal gears at least two years.

What it Does

Now mind—and this is important—all the parts involved in transmitting this power *have nothing whatever to do with load carrying.* They *concentrate* on power transmission. That is why they can do so much work without being heavy aud cumbersome.

All the load* is carried on a strong patented I-Beam, which has *nothing whatever* to do with *driving.* That is why Torbensen Axles are so strong and last longer than any *truck.

These two groups are held together in practically perfect, permanent alignment. Together they form Torbensen Drive.

Due to this construction, Torbensen Drive adds at least 20% to rear-tire mileage, cuts down repairs and delays and saves gas and oil.

Write to us for an informative booklet explaining clearly every feature of Torbensen Drive.

THE TORBENSEN AXLE COMPANY
CLEVELAND, OHIO

Largest Builder in the World of Rear Axles for Motor Trucks

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of SCIENTIFIC AMERICAN.

Pertaining to Apparel

PROTECTIVE HELMET.—C. LA F. STOCKS, Blue Ridge, Ga. The invention relates to generally to wearing apparel and more particularly to protective helmets the object being to provide a helmet capable of effectively protecting the head, face and neck against flying shell fragments and other missiles so as to reduce head face and neck wounds as far as it is possible to do so. The helmet consists of inner and outer casings resiliently spaced apart; with means whereby the inner casing is supported upon the head.

ATTACHMENT FOR SUSPENDERS.—A. B. SCOTT, Fairmont, West Virginia. This invention has for its object to provide an attachment for suspenders which may be readily attached to the loop at the end of the suspender strap, the attachment is so constructed that it may engage the shirt and hold it against the suspender button at the inner side of the trousers, by pressing the attachment against the shirt over the head of the suspender button to a position where the attachment will press the shirt against the shank of the suspender button.

Pertaining to Aviation

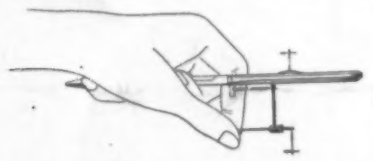
AIRSHIPS.—P. J. PROKOP care of Dr. Kovacs, 233 E. 68th St., New York, N. Y. Among the objects of this invention are to provide air navigating vessels of relatively great speed through the application of a principle, which may dispense with the usual supporting planes if desired, which are very simple in construction and operation, and which may be made of very great load bearing capacity.

Of Interest to Farmers

REGULATOR FOR INCUBATORS.—C. C. CARTER, P. O. Box 2 Chapin, Ill. The object of the invention is to provide members which may be opened to quickly cool and change the air in an incubator when the temperature rises above a predetermined point, the means provided for opening the members also serving to open a damper connected with the incubator heater.

Of General Interest

NEEDLE-THREADER.—M. NIELSEN, P. O. Box 14, East Seattle, Wash. The invention relates to a needle threader including a magnifying glass, a needle holder which is adapted to present the needle opening in the focal plane of the glass.

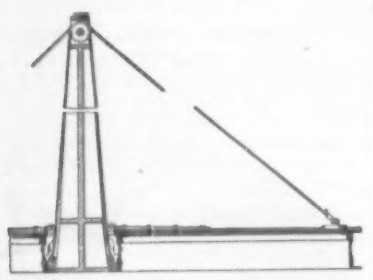


AN EDGE ELEVATION SHOWING THE THREADER IN OPERATIVE POSITION

An object is to provide a simple and inexpensive threader which can easily be applied to scissors, a suitable holder for the glass, to protect its surface, being provided in the handles of the scissors, and a foldable socket for a needle in a line lying in the focal plane of the magnifying glass.

FLUSH TANK.—N. PRICE, 441 64th St., Brooklyn, N. Y. Among the objects of this invention is to provide a flushing tank for toilet bowls, that will be practically non-leakable and provided with a valveless supply pipe connection Another object of the invention is to improve that type of flush tanks which have the charge of water maintained under pressure equal to the pressure of the supply leading to the building or from the building to the tank, whereby there is insured a prompt and rapid discharge of water from the tank for flushing purposes.

HATCH COVER LIFT.—W. H. HUNT care of Boston Seamans Friend Society, 287 Hanover St., Boston, Mass. The invention relates to lifting devices for lids or covering members, and has for an object the provision of a construction for raising the covers of the hatches of ships in



A FRAGMENTARY SECTIONAL VIEW

such a manner as to quickly and easily remove any cover or all covers simultaneously. Another object is to provide an arrangement of lifting devices which will allow the easy raising of hatch covers of any weight by a minimum manual effort.

REVERSIBLE BOAT.—T. H. GASKIN, Grove Road, Woodford, England. This invention relates to reversible boats or rafts adapted for being carried on ship board and capable of being used in place of the ordinary non-reversible life boats with which ocean-going vessels are as a rule provided. The device has a combination of a peripheral buoyancy chamber whereof the depth is substantially equal to the total depth of the structure, and a series of hermetically-sealed air-tanks independent of the structure of the boat, housed within the peripheral buoyancy chamber and interspersed between the decks.

SAFETY TRACE CONNECTION.—A. THOMSON, Fitchburg, Mass. The invention relates generally to trace connections, and more particularly to a trace connecton adapted for use in connection with metallic collars, the object being to provide a connection which may be quickly and effectively made and which, when effected will defeat all tendency of the parts towards relative displacement, the connection is of the hook-and-eye type which will be flexible in engaged position.

HORSE-COLLAR.—A. THOMSON, Fitchburg, Mass. This patent relates generally to horse collars, but more particularly to those of wholly metallic construction, the prime object being to provide for a better and more effective shaping of the collar as a whole, as well as for a wider range of adjustment which, results in better fitting of the collar to the neck of a particular horse, also a construction capable of more ready maintenance in cleanly sanitary condition.

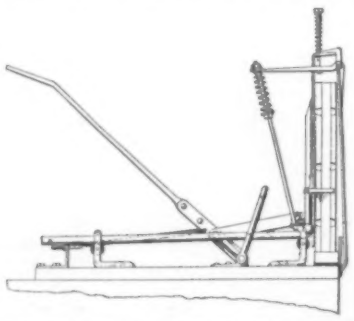
Hardware and Tools

NUT LOCK.—J. A. KUBY, 173 Lexington Ave New York, N. Y. The principal objects of this invention are to lock the locking member of a nut lock in active position, to release the locking member manually, to provide a simple construction for locking screw-nuts in active service relation, and to facilitate the assemblage of the members constituting the lock.

PAINT BRUSH.—F. L. BENEDICT, 1028 Cathedral Street, Baltimore, Md. This invention relates particularly to rotary brushes, an object being the provision of a construction whereby the device may be used for applying paint, or may be used for cleaning a surface preparatory to receiving paint, or other coating material. Another object is to provide a brush in which the paint is sprayed over the surface and substantially simultaneously spread by rotating brushes, a proper distribution being produced as well as a rubbing in of the paint.

PERMUTATION LOCK.—O. KLEIN, address Jacob Truchinsky, care of Hudson Auto Lamp Co., 51st St. and Broadway, New York, N. Y. The general objects of this invention are to simplify the construction and operation of devices of this character, so as to be reliable, comparatively simple, and inexpensive to manufacture, and so designed that the combination can be easily and quickly changed when occasion requires. A further object is the provision of an arrangement of tembiers and baffle plate with means whereby the barrel of the lock can be operated so as to act as a bolt-throwing means by the pressing of a button when the tembiers are in desired position.

AUTOMATIC BLOCK DROPPER.—G. C. MUMMA, 115 S. 14th St., Decatur, Ind. The present invention relates generally to baling presses, and more particularly to automatic means for dropping the head blocks into the baling chamber. The device compresses, the combination of a horizontally movable carriage having yielding spring controlled arms at its forward portion for engagement with the head block, and



SIDE ELEVATION WITH THE CARRIAGE IN RETRACTED POSITION

open at its opposite side for introduction of the head block, the carriage including latch bars, means for shifting the carriage forwardly, mean controlled by the yielding arms of the carriage and engageable with the latch bars to lock the carriage in its forward position, and means for returning the carriage to its rear inoperative position when the latching means are released.

REAMER.—E. F. MILLER, 306 Prospect St., Meadville, Pa Among the principal objects of the invention are, to tighten inserted knives in a cutter head, to reinforce the seating pressure thereof, to permit unrestricted movements of the cutting members, to hold the members in adjusted position, and to lock said cutting members positively in the cutter head against displacement.

COMBINATION PIPE CUTTER AND COUPLING SPLITTER.—W. H. DEAN, Leeds Station, Sioux City, Iowa. An important object of this invention is to provide a tool that may be readily applied to a pipe and adjusted and operated as a pipe cutter or for the purpose of producing a slit longitudinally in a pipe coupling, so that a cold chisel or like tool may be entered and caused to split the coupling.

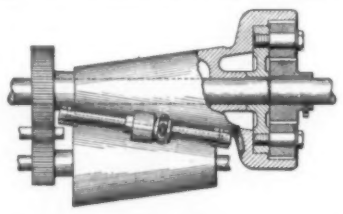
HAMMER DRILL.—D. SPEHAR, Box 332, Miami, Ariz. One of the principal objects of this invention is to provide a hand prospecting drill, of the hammer type, so constructed as to be collapsible that it may be placed in a hand bag or satchel for transportation, the drill is particularly designed for use in quarry and mine work, having means for effecting a delivery of blows by the hammer and an arrangement for effecting a rotary motion of the drill bit.

Heating and Lighting

CARBID HOLDER REGISTER.—P. E. and F. A. WEBB, Protection, Kans. The invention relates to artificial gas lighting apparatus and has particular reference to acetylene gas generators. Among the objects is to provide a self-contained generating device including a carbid holder having means for dispensing measured quantities of the carbid from time to time into the body of water at the bottom of the machine, and to provide means whereby the operator may readily observe at any time on the outside of the machine the amount of carbid retained in the holder.

Machines and Mechanical Devices

TRANSMISSION.—B. STEVENS, 2646 22d Ave., Oakland, Cal. The invention relates to transmission mechanisms of the frictional type



AN ELEVATION, A PORTION BEING BROKEN OUT TO SHOW DETAILS

coupled with a planetary gear system. An object of this invention is to provide a simple, efficient and strong transmission through which power can be transmitted at variable speeds.

PRINTING MACHINE HAVING A CONTINUOUSLY ROTATING CYLINDER.—C WINKLER, Berne, Switzerland. According to this invention a press of this kind is so improved that the attendance and accessibility is much facilitated and the external dimensions reduced to a minimum Further means are provided to obtain an accurate register in placing the sheets into the machine and to admit of the sheets being delivered from the printing cylinder with the freshly printed surface upward.

WATER ELEVATOR.—B. F. STAUBER, 02.904 Lee St., Spokane, Wash. The invention relates to the utilization of the power of currents of rivers, creeks, and other moving bodies of water, to operate suitable machinery, in the present case a pump, and the main object is to provide such a device which is adapted to be anchored in a stream and to be so set in such position as to avail itself of the flow of water in the stream, a further object is to provide a water-wheel arrangement which may be adjusted to meet the conditions, and to provide the wheel with relatively great leverage to correspondingly affect the connected pump or other machinery.

CENTRIFUGAL GUN.—A. E. BROWN, 407-08 Mills Bldg., El Paso, Texas. The invention has for its object to provide a device wherein a fixed barrel is provided and a rotating discharge and feeding member adapted to be rotated, rapidly and carrying the balls which are fed to the barrel and discharged forcibly therefrom one by one, and wherein the gun is so arranged that the balls may be fired in any desired direction

BALL AND ROLLER BEARINGS.—F. STARIN, 304 N. Main St., Springfield, Mass. The object of the invention is to provide certain useful improvements in ball an roller bearings whereby the inner and outer rings can be securely held in the chucks to permit accurate finishing or grinding of the faces of the bearing rings, that is, finishing three faces of each ring while held in one position in the chuck and finishing the fourth face while held in another position in the chuck.

GRAIN POLISHING MACHINE.—H. J. PIEPGRAS, Caldwell, Idaho. The general objects of the invention are to provide a machine having the maximum efficiency in thoroughly and expeditiously effecting the polishing of the grain More specific objects are to provide an effective agitating, polishing and conveying means to force the polished grain through the outlet against the head or pressure produced by the column of escaping grain, as well as to simplify the construction of machines of this character.

AUTOMATIC FEEDER FOR MOLDING AND MATCHING MACHINES.—J. E. BROWN 457 59th St., Brooklyn, N. Y. This invention relates to woodworking machinery and deals particularly with a feeder whereby boards of various lengths may be fed successively and in a continuous manner to the machine, its general objects are to provide an automatic lumber feeder of such construction that a quantity of lumber necessary for a day's run of the molding or matching machine, can be fed, it being merely necessary for the operator to pile the lumber in regular stacks side by side on a pile carrier which moves intermittently to carry the successive stacks to feeding position.

Pertaining to Vehicles

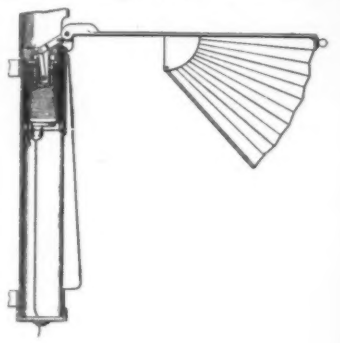
MUD HOOK CLAMP.—C. C. GRAY, Wapakoneta, Ohio. The invention relates to mud-hook clamps, its object being to provide means for attaching mud hooks to the wheel of a motor vehicle, in such manner that they will be held firmly in place during the movement of the vehicle, while at the same time they may be easily attached to or detached from the wheel. The hook plate is made fast to the wheel by tightning chains and an elbow lever, six degrees of adjustment are permitted.

AUTOMOBILE STEERING WHEEL.—G. T. OTTE, address, Chas. C. Lloyd, care of Butler Bros., 495 Broadway, New York, N. Y. Among the principal objects which this invention has in view are, to change the location of the steering wheel without discontinuing the working condition thereof; to adjust the working position of the wheel, and to lock the wheel and steering mechanism connected therewith for preventing the operation of the automobile on which the wheel is mounted.

VEHICLE WHEEL TIRE.—W. N. KNOWLTON, 133 Milton St., Brooklyn, N. Y. Among the principal objects of the invention are, to avoid the necessity for the use of air in tires of the character described, to supply a multiplicity of independent resilient units for supporting the weight imposed on the wheel, to provide cushion members for the tire, which may be readily renewed, and to provide a substitute for the pneumatic tire used in vehicle wheels, by a plurality of metalic springs, disposed in recesses between cushion rings.

RADIATOR.—F. W. KEEGAN, care of D. McRa Livingston, 159 E. 36th St., New York, N. Y. The invention is more particularly designed for use in cellular radiators employing zig-zag water tubes and radiating elements presenting a honeycomb patern, though the invention is not limited to this type. The prime objects are to provide a radiating element having a maximum efficiency by reason of presenting an increased total of radiating surface, and a radiating element that will support and brace the water tubes and materially strengthen the structure.

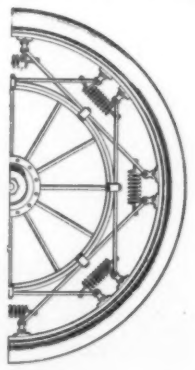
VEHICLE SIGNAL.—G. W. EDMOND (deceased), Leo C. Edmond, Executor, address J. M. Nealon, 1st Natl. Bank Bldg., El Paso, Texas. The invention relates to signaling devices particularly suitable for use on automobiles to indicate a change of course. The object is to provide an inexpensive and efficient contrivance which can be easily applied to an automobile



A SECTIONAL VIEW SHOWING DEVICE IN OPERATIVE POSITION

so as to become prominent when actuated to attract attention, and for this purpose when thrown into the operative position a folding flag is attached near the free end of the arm, the flag unfolds automatically, to render the arm apparent in the dark, an incandescent light is provided at the extremity of the arm.

SPRING WHEEL.—W. J. DAVIS, Redig, South Dakota. The invention has for its object to provide a wheel especially adapted for heavy motor vehicles, wherein resilient mechanism is arranged between the rim and the hub for cushioning the hub against the rim. An inner wheel is provided consisting of a hub, a rim, and spokes



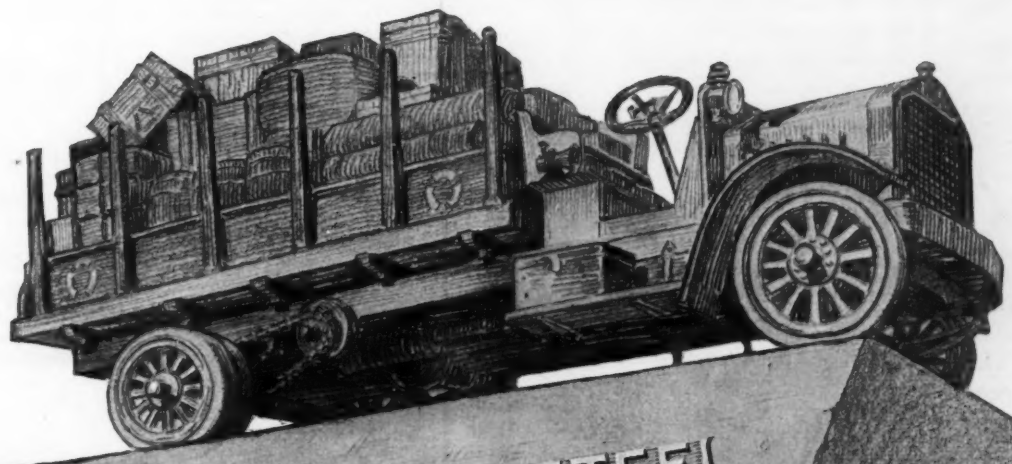
SIDE VIEW OF A PORTION OF THE WHEEL

connecting the hub and the rim, and an outer auxiliary rim arranged concentric with the wheel, this rim carries a solid tire and is connected to the inner rim by a series of straight plate springs which are made fast to the inner and outer rims, the plate springs are connected by coil springs being passed through openings in the plate springs.

RADIATOR.—D. MCRA. LIVINGSTON, 150, E. 36th St., New York, N. Y. The invention relates to cellular radiators employed on automobiles. More particularly it relates to a type of radiator in which hexagonal air cells are formed jointly by opposite walls of two corrugated water tubes and by an intermediate radiating unit The invention is characterized by an expanded radiating element in which a single plate is expanded at intervals in opposite directions to form parallel hexagonal cells in the radiating element, the respective cells being separated by and alternating with unexpanded members presenting plane zones.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Burden Bearers



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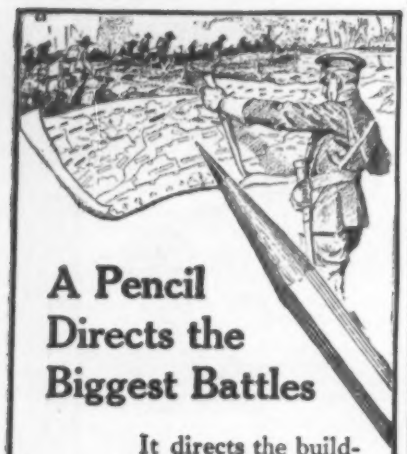

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735.—A merchant in Algeria wishes to purchase wooden chair seats in perforated designs or pyrographed and varnished with brush and stamp. Samples of seats and descriptive literature of same, such as are desired, may be examined at the bureau or its district offices. Reference.

736.—A company in China desires to purchase or secure an agency for the sale of window glass. The glass should be put up in cases containing 100 square feet. Quotations may be made f. o. b. Pacific coast port with estimate on ocean charges. Payment will be made by sight draft against documents or 60 days' credit. Complete information should be submitted so that goods can be ordered by cable if desired. Correspondence may be in English. References.

737.—A firm in the Dominican Republic desires to secure an agency for the sale of barbed wire, carpenters' tools, plows, general hardware, electrical goods, packed goods, lubricating oils, cement, rice, flour, cotton goods, ready-made clothes, wines, whisky, etc. Quotations should be made f. o. b. New York. Payment will be made by sight draft, 30 or 60 days. Correspondence may be in English. References.

738.—An agency is desired by a man in Switzerland for the sale of coconut oil for food and industrial purposes. From 100 to 200 barrels are desired. Quotations should be made f. o. b. New York or other American port. Payment will be made by cash in New York by confirmed credit. against documents. Goods will be consigned through Swiss shipping company in New York. Correspondence may be in English. References.

739.—A firm in Italy wishes to purchase and secure an agency for the sale of mowers, autoplows, and other agricultural implements. Estimate on freight rates to Genoa should accompany offers. Cash will be paid. Correspondence may be in English.

740.—A man in India desires to purchase and secure an agency on a commission basis for the sale of chemicals, such as hydrosulfite of soda conc. powder, for working and setting indigo vat dyes; sulfate of ammonia, seventeen-eighteenths per cent entirely free from iron, in white pebble forms, packed in 5-hundredweight casks; brown sugar of lead; antimony salts, 65 per cent; potash bicromate; bicromate; bicromate of soda; sodium sulfide, 65 per cent; caustic soda; soda ash, in double bags of 2 hundredweight each; washing soda; magnesium chloride; zinc chloride, 98 per cent pure; sulfur; congo red, etc. Samples should be submitted. Payment will be made through house in New York. Correspondence may be in English.

741.—A firm in Scotland desires to purchase rubber-stamp goods, sign markers daters, numerators, etc. Quotations should be made f. o. b. New York. Payment will be made by cash against bills of lading. Goods should be sent through American Express Co. References.

742.—A company in Italy is in the market for any gelatinous substance for making a filler for electric cells or batteries that will remain dormant until water is added. The substance should be in powdered or dry form, capable of being stored without deterioration, and that becomes active by addition of water. It also desires to purchase dioxide of manganese, graphite, zinc, and sal ammoniac. Samples should be submitted as soon as possible. Correspondence may be in English. References.

743.—A firm in the Azores wishes to buy phosphoric fertilizers, sulfuric copper, and sulfuric iron. Lowest cash quotations are desired f. o. b. New York. Correspondence may be in English.

744.—A wholesale buyer in Italy is in the market for all kinds of leather goods, such as leather bags, traveling articles, morocco packet books, purses, etc.; celluloid articles, such as combs, brushes, umbrella handles, etc.; parasol and umbrella parts and accessories; articles of art, such as fine hardware, metal frames for clocks, vases, inkstands, cigar boxes, and novelties; canes and walking sticks; metal cigarette lighters and cigarette holders of various types, etc. Payment will be made by opening credit at local bank, avaliable against shipping documents. Correspondence should be in French or Italian. References.

745.—An agency is desired by a commission agent in Spain for the sale of combination lock safes. Correspondence should be in Spanish. References.

746.—A firm in Portugal wishes to purchase machines, tools, etc., for use in factories. It also desires to entertain an agency proposition for the sale of same. Payment will be made against documents or other terms desired by shipper. Correspondence should be in French or Spanish. References.

747.—A merchant in Italy desires to purchase black and colored pencils, ink pencils, pen points, drawing pens, crystal and glass ink stands, stationery, black and colored printing inks, etc. Quotations may be made f. o. b. New York. Payment will be made by opening credit at a local bank when giving order, available against shipping documents. Correspondence should be in French or Italian.

748.—A company in England is in the market for steel channels for ricksha wheels for inserting rubber tires 1½ inches inside and 1¾ inches outside; plain and corrugated galvanized iron; mild steel sheets; iron sheets; and steel bars. Quotations should be made f. o. b. New York. Payment will be made by cash against shipping documents in New York. Reference.

749.—A firm in Switzerland wishes to buy large quantities of glow lamps with metal filament and ½-watt glow lamps assorted; contact-breakers 4, 6, and 10 amperes; and sockets for glow lamps. Payment will be made against bill of lading. Correspondence may be in English. If desired, a deposit will be made in a Swiss bank as a guarantee for the contractors.

750.—A firm in London wishes to buy oil table lamps and glass electric light shades. Quotations should be made f. o. b. New York or San Francisco. Payment will be made by cash in the United States. Reference.

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Strategic Moves of the War

(Concluded from page 454)

for a most successful defense and possibly for counter attacks.

Heavy winter weather has already set in on the northern battle line; this will undoubtedly greatly interfere with the German lines of communication if it does not break them. On the east such weather must similarly interrupt or destroy their lines to the east. On the north there is but one line of railroad that can be of service under present conditions, that from Trent through the Val Sugana to and along the Brenta; to the east there are only two main lines open for supplies and communications—one from Villach to and along the Tagliamento River to a connection with the road from Udine to the west. The other runs from Villach or Klagenfurt through Gorizia and Latisana in the direction of Treviso. If the assaults upon the Asiago plateau and the Brenta-Piave lines are not successful, it would seem that the Austro-German forces would be forced to withdraw at least to the Tagliamento River in order to keep up during the winter their communications and supplies. On the other hand, the allied Italian, British and French troops have their lines open to the south and west and can increase their forces and supplies from now on by means of the network of Italian railways.

So far Monte Tomba and Monte Funera appear to be the crucial points of the defense of the whole Italian line along what may be called the plains section of the Piave-Brenta lines. These mountains are the last high ridges of the Monte Grappa plateau between the upper Alps and the plains that slope to the south toward Venice and the sea. The ridges begin near Feltre north of Quero and run in a general direction southwest toward the Brenta, reaching that river some miles north of Bassano where the Brenta leaves the mountains for the plains. The most elevated point of the ridge is Monte Grappa—5,700 feet high—about half way between the Piave and the Brenta; the peaks of the ridge become gradually lower east and west until the rivers are reached. South of the ridges there is a good highroad running all the way between the two rivers; this road is the objective of the Austro-German movement as it would give good routes to Bassano on the Brenta and to the Piave south of Quero.

It is said that the Austro-German commanders know the absolute necessity of capturing the strongholds of Monte Grappa as shown above, and are therefore increasing every day the pressure upon the Italian lines defending them; but the Italian resistance has been superb, based as much upon absolute determination to hold out as upon their lines of defense. So far the enemy has not obtained even a partial success, but it is believed that the recommencement of the offensive on a much larger scale is imminent—especially on the Asiago plateau, where a movement in the direction of Vicenza is probable.

New Steam Motor Truck

(Concluded from page 458)

that a gallon of lubricating oil is sufficient to run a truck for about 7,000 miles.

As the steam motor truck uses only kerosene for fuel and the consumption per mile is only a little greater than that of gasoline in a gas-driven truck, it will be seen that considerable economy is secured. Further, economy results from the fact that steam truck drivers cannot leave their motors running while the trucks are idle. When the steam motor truck is standing, the fuel feed is automatically reduced to what is necessary to keep the steam pressure up to the desired point.

The Engine

The steam is led to a two-cylinder single-expansion, double-action engine, with cylinders of four-inch bore by four-inch stroke, placed at 90 degrees. Two D slide valves, one for each cylinder, are used, and they are actuated by a special Stevenson valve-gear, which permits a cutoff at 80 per cent of the stroke for starting. In normal operation the cutoff is 20 per cent.

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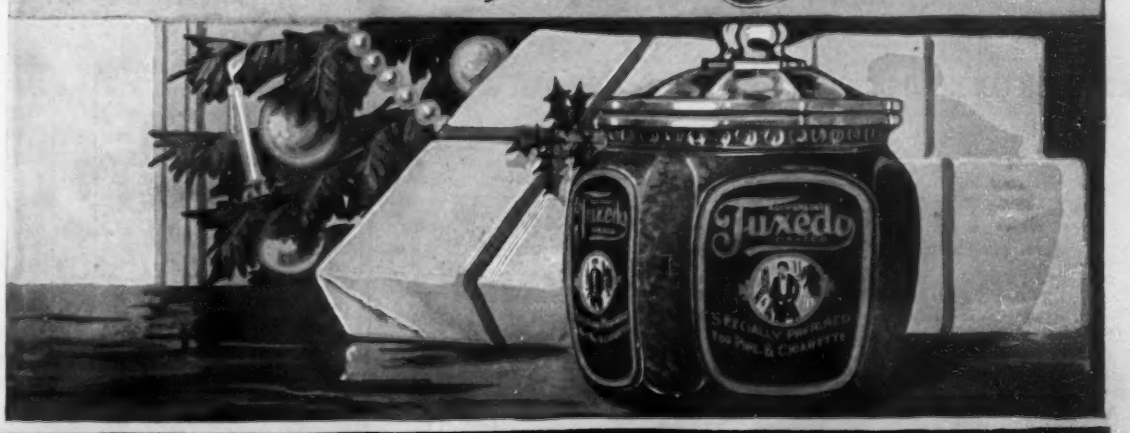

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The Class A Liberty Truck

(Concluded from page 460)

and brake drum. The latter is of larger diameter than the gear and much deeper, so it completely covers the drive. The gearing is inclosed as tightly as possible, and is nearer the wheel than the brake. The drum has its largest diameter right in line with the joint in the gear casing, being smaller on the actual brake surface, and this gives a sort of annular pocket, back of the brake, which catches any lubricant exuded from the gear. A ring of holes is drilled to allow escape of any such grease or oil. Any which gets out of the gear will be flung to the largest diameter of the drum by centrifugal action and thrown off outside the brake.

Gear ratios are higher than on the heavier truck. The direct drive is 8.4 to 1, the others being respectively, 14.3, 32.4 and 42.5 to 1. Tires are 36 by 7 rear and 36 by 4 front.

The same drive is used as on the B type, the rear springs being 56 inches long and the front ones 42 inches. Both are divided in the center. There is a new system of spring-belt lubrication somewhat simpler than that used on the class B. The spring eye, shackles and brackets are bushed and instead of the usual spring bolt, a piece of steel tube is pushed in, free to turn either in the spring eye or in the shackle. This is prevented from endwise movement by a small bolt which clamps the whole together.

On the inner end, this bolt secures a plain cap, sealing the end of the tube, but on the outer end the bolt holds up a little oil box. This is a casting with a small reservoir below the level of the spring eye, and there is a small splash plate above, the idea being that oil will be thrown up by vibration on to the plate, whence it runs into the spring supporting tube and so to the bearing surfaces. Overfilling the reservoir will flush the whole unit, washing out dirt and old oil. In normal times this would be patented and marketed as a high-priced accessory; its use here is an excellent sample of how several engineers getting together can perfect a detail—of course it is free to Uncle Sam.

Elsewhere the truck differs little from the large one. It has the same equipment, the same fuel feed from a dashboard tank, the same steering, scaled down of course, the same frame design. It will not have the four-man seat, only two men being carried. The wheelbase is 144 inches.

The work of the design has been carried out under the direction of General Chauncey Baker, Q.M.C., by B. B. Bachman, chief engineer of the Autocar Company, and E. E. Wemp, chief engineer of the Denby Motor Truck Company. For the detailed working out of the engine, W. A. Frederick of the Continental Motors Company is responsible.

The Simulation of Disease

A handy résumé of the various methods of shamming disease which involve the use of drugs, chemicals and septic materials is given by A. G. Dumez, of the U. S. Hygienic Laboratory, in *Public Health Reports* for November 9th. The subject is of timely interest as it comprises the means most frequently employed by dishonest shirkers of military duty.

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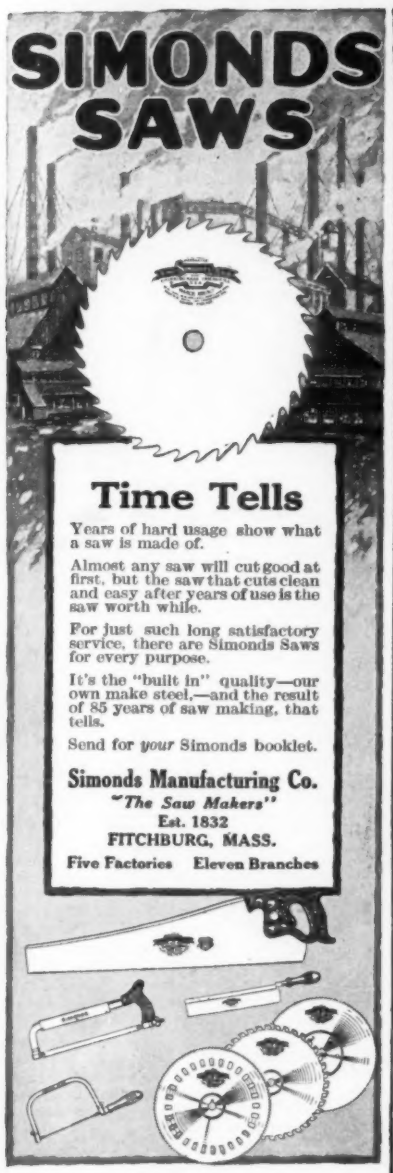
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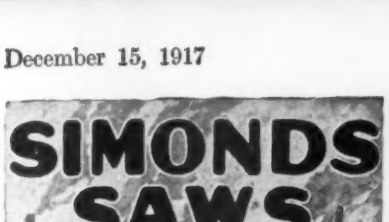

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Why Germany Is Losing the War

(Concluded from page 449)

and reckoning the hopelessly crippled at 1,350,000 men, which is about the ratio of cripples to dead as determined in this war, we get a loss of 2,500,000 in the first two years and a total loss of about 5,000,000 men by August, 1918.

General Maurice, replying recently to General Ludendorf's statement that the British in making their slight gains in Flanders, this year, had lost 500,000 men stated that they had never that number engaged on the sector in question. He stated, further, that they had accurate knowledge that the German losses had been 75 per cent greater than those of the British.

There is nothing surprising in this statement. Not only have the British a great superiority in gunfire—as have the French—with superior observation by aeroplane, but the Germans have frequently made a dozen or more counter attacks in close order during the furious fighting on the Somme and before Ypres. Their losses must necessarily be enormous.

Now the British losses as officially reported have been running as high as 30,000 a week. Eighty per cent of these, at least, or 24,000 must have occurred on the western front. During the winter months the losses have averaged about 10,000 per week. This gives an average for the year of 17,000 per week on this front.

Increasing this by 75 per cent gives a German loss on the British front of 29,750 per week.

Their losses to the French at such battles as the Marne, Champagne, Verdun, the Chemin-des-Dames, cannot be less—they may indeed be more.

The terrific fighting on the Russian front coupled with the Serbian, Roumanian and Italian drives may readily have resulted in an average casualties of say 26,000 per week among the Germans.

The total average casualties, on all fronts then would reach 85,500 per week. This would mean a total of 4,446,000 casualties in one year.

Now at the ratio of five wounded to one dead this would give a total of 741,000 dead per year.

The Germans have made some fantastic claims as to the number of wounded that are returned to full active service—claims of well over 90 per cent. If 76 per cent are so far restored that they can carry a rifle and endure the frightful ordeal of trench fighting it would be a notable result. Assuming 76 per cent so restored, we find that of the wounded, 889,200 are permanently crippled and rendered unfit.

But there is yet another leak in this cistern of man-power, which curiously is always overlooked. We refer to the fact that soldiers die from sickness as well as civilians. Our census of 1910 shows that the average death rate between the ages of 20 and 45 is about eight per thousand. The damp conditions of trench life, coupled with the extraordinary mental strain of modern warfare, will raise the rate above that of American civilian life, especially as undeveloped boys of 16 years and men up to 45 years of age are found in the German army. Assuming a rate of 10 per thousand, the loss through sickness would reach 68,000 per year. This figure would probably be maintained, because though the total army has decreased the quality of the troops has greatly deteriorated.

A summary of these totals for killed, permanently crippled, and dead through sickness, gives a yearly total of 1,698,200 men absolutely lost. To compensate for this Germany calls to the colors each year about 450,000 young men; not 600,000; which is a figure they give out for public consumption. The total annual loss therefore is 1,248,200. And if this rate be maintained until August, 1918, the total net loss will be 4,992,800 or say 5,000,000 men.

This it will be noted agrees with the total loss, as determined by the Allied Secret Service from the official notifications made by the government to the relatives of soldiers lost at the front.

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LEARNING TO FLY IN THE U. S. ARMY. A Manual of Aviation Practice. By E. N. Fales, Assistant Professor of Mechanical Engineering, Chair of Aeronautics, University of Illinois. New York: McGraw-Hill Book Company, 1917. 12mo.; 190 pp.; illustrated. Price, $1.50.

Our entrance into the war resulted in a call to the colors of some 30,000 aviation students; our schools of military aeronautics are expected to turn these students into qualified airmen in the course of a few weeks, although many of them have had no technical training. This requirement can only be met by sheering the instructions down to absolute essentials. This Prof. Fales has done by the most painstaking selection and condensation of material; the result is a much-needed textbook by the aid of which the student may quickly acquire a knowledge of types and uses, the principles of flight, the actual operation of the craft in the air including points on cross-country flying, the materials of construction, erection, and rigging of the aeroplane, and the truing up of the fuselage. The work gives the gist of what the aviator must know, without sacrificing accuracy to brevity, and is admirably adapted for use as a text-book in the present emergency.

FLOTATION. By T. A. RICKARD, Editor of the Mining and Scientific Press, and O. C. Ralston, U. S. Bureau of Mines. San Francisco: Mining and Scientific Press, 1917. 8vo. 416 pp.; illustrated. Price, $3.

TIMBER FRAMING. By Henry D. Dewell, Assoc. M. Soc. C. E. San Francisco: Dewey Publishing Company, 1917. 8vo. 275 pp.; illustrated. Price, $2.

The first of these works deals with flotation processes in metallurgy and the physical principles upon which they rely. There is a succinct history of the art, and its principles are made understandable by clear description accompanied by diagrams. The past few years have recorded rapid progress in practical applications, and most of the volume is devoted to this recent development; aside from interesting papers of a more general nature, there are specific studies such as that of flotation at Calaveras Copper, which carries an illustration of the cell arrangement and a flow-sheet diagram; mechanical development is traced the process as applied to oxidized ores and gold and copper is sketched, and their are chapters on "tribulations," litigation, and cost data. "Timber Framing" embodies the results of eleven years' experience. The literature of timber construction is all too scant, particularly in details of design; the author has followed his designs into the field, has carefully tested different types of timber joints, and has thus often been able to simplify the work of the carpenter while retaining all effective features. The volume establishes working-values that will be appreciated by the structural engineer, at the same time admitting that certain of the theories advanced and conclusions drawn may have to be modified in the light of more extensive tests.

THE INSURANCE ENGINEERS' HAND BOOK. By William D. Matthews, E. E. Louisville, Ky.; The Insurance Field Company, Inc., 1916. 12mo.; 680 pp.; illustrated. Price, $4.

This excellent handbook, which largely extends the field covered by the old "Manual of Inspections," serves a double purpose, that of a textbook in fire protection and fire preventive engineering study courses, and that of a reference book comprehensive enough to appeal to the profession and the interested public. Under the subject-headings of construction, hazards, protection, and general information is presented a wealth of valuable material with the fire hazard as the ultimate consideration. Private and public fire protection, signaling systems and automatic sprinklers are dealt with at considerable length, and the final section of the manual includes a glossary, field notes, insurance maps with a folder in color as an example, inspections, report writing, and many tables and formulas applicable to the needs of the profession.

MY FOUR YEARS IN GERMANY. By James W. Gerard, Late Ambassador to the German Imperial Court. New York: George H. Doran Company, 1917. 8vo.; 465 pp.; illustrated. Price, $2 net.

It is extremely difficult even to select for mention a few of the pregnant aspects dealt with in this wonderful book, written by a representative American of whose achievements the nation may well be proud. The social structure of the German Empire, full of contradictory merits and faults, is drawn for us with the simple precision of a master hand. The pernicious, paternalistic system of reward and punishment that has permeated and rotted the entire structure is nakedly disclosed; yet no sentence breathes animosity, nor does sanity even for a moment tremble in the balance. We accompany our Ambassador to Berlin; we regard the ridiculous ceremonials of court life through his clear, humorous eyes; we meet German honesty toward which our heart warms, and German blindness and perfidy that seems to be rather an epidemic disease of which the Emperor is the first source—a sort of king's evil. Mr. Gerard's theory of the basic responsibility for the war is that "the fear of war induced by a hereditary instinct, caused the mass of the Germans to become the tools and dupes of those who played upon this very fear in order to create a military autocracy." Other chapters develop the geographical, militaristic and commercial situations all of which, given the viewpoint of unbounded ambition, made the country ripe for brutal aggression. Mr. Gerard insists that we have little ground for hope of peace through internal revolution, but his chapter on "Liberals and Reasonable Men" allows us to extract some comfort from the possibility of a new political party that shall inaugurate a true parliamentary reform. This remarkable book should be read by every thinking man and woman; its shrewd appraisal of the German mind, its keen, world-embracing observation, its facsimiles of astounding secret documents, make its importance as a contribution to the literature of the war outstanding and unquestionable.

THE ORIGIN AND EVOLUTION OF LIFE. By Henry Fairfield Osborn, Sc.D. New York: Charles Scribner's Sons, 1917. 8vo.;354 pp.; 136 illustrations. Price, $3

Ever since Spencer and Darwin gave to the world their revolutionary conceptions of life and its physical unfolding we have continued to learn much of the *how*; but the *why* has proved persistently elusive. Our failure, Prof. Osborn thinks, may be partly due to the fact that we have been thinking from matter back into energy, rather than from energy forward into matter and form; so in these lectures he leads us toward an energy conception of evolution and heredity; action and reaction have long been studied, but here we have indications of that newer knowledge of the mysterious workings of interaction with its curious resemblance to germ evolution. The author is one of our most lucid writers on scientific subjects, and when he affirms his belief that a certain theory of action, reaction and interaction here set forth brings us "somewhat nearer a consistent physicochemical conception of the original processes of life," we may be sure that the volume is well worthy of attention; indeed, by giving us a new viewpoint, it throws upon certain obscure activities gleams that may well herald the dawn of a new era in biological knowledge.

AGRICULTURAL DRAWING. By Ralph F. Windoes and Harvey B. Campbell. St. Paul: The Webb Publishing Company, 1917. Eight by 10¾ inches; 149 pages; illustrated. Price, $1.50.

At the outset it is evident that th's book has been prepared by capable hands, for Mr. Windoes is instructor of Mechanical and Architectural Drawing at the Davenport High School, Davenport, Iowa, and Harvey B. Campbell, B.S., is director of architectural drawing and design at the Westport High School and the Y. M. C. A. Industrial Night Classes, Kansas City, Mo. Both have had invaluable experience in teaching the very subject which forms the theme for their present work. And then Mr. Windoes has written not a little on this and various allied subjects in the past, both in periodical and in book form. Starting with suggestions on equipment and methods of teaching, the present work runs the gamut of architectural drawing. Among the subjects covered are architectural lettering, foundations, framing, mouldings, details in building construction, wall coverings, stairs, preliminary planning, working drawings, perspective, shades and shadows, rendering, specifications and estimates, plumbing, heating and ventilation, building a home of one's own, data and miscellaneous tables, and suggestive designs. All these subjects are covered at length in a clear, readily-understandable style. The illustrations, which are profuse, are most commendable in their execution.

DARWINISM AND HUMAN LIFE. By J. Arthur Thomson, M. A., LL.D. New York: Henry Holt & Company, 1917. 8vo.; 277 pp.; illustrated. Price, $2.00.

The author has given us a re-evaluation of our debt to Darwin, has cleared away many of the misinterpretations that have hampered a proper understanding of the struggle for existence and the theory of natural selection, and has indicated the progress made since Darwin's time and the problems that still confront us; in short, the work is a very good introduction to the study of organic evolution, with particular reference to its bearing upon human life, both individual and national. The call for a third edition has provided opportunity for the incorporation of new material, an opportunity of which the author has not hesitated to avail himself. A long list of representative books on Darwinism is appended conveniently classified according to their relationship to successive chapters of the work in hand.

HEAT. By John Roger. New York: John Roger, West 40th St. 12mo.; 77 pp.

Some of the main contentions of this work may be summarized as follows: That heat is a diamagnetic force acting in opposition to the positive force of attraction; temperature, the negative atomic stress produced between the atoms. That the work value of the unit of heat is not 778 foot pounds, but is proportionate to the temperature, and that the unit of energy 778 foot-pounds may apply anywhere on the scale of temperature without reference to the unit of heat. That there is no such thing as latent heat, but only developed and undeveloped energy. Much of the book is concerned, directly or indirectly, with a more exact nomenclature. Cavendish rejected the term "latent heat" a century ago, though not precisely on the same grounds as those of the present writer; the term "calorimetry" also harks back to the materialistic idea, yet we retain it; for a certain accepted meaning is now attached to such terms, they permeate the history and literature of the subject, and they have usage and convenience in their favor; certainly "undeveloped energy" would not further the purposes of exactness. Still, putting aside such portions of the discussion as deal with modes of expression rather than with basic facts, there is residuum of argument that will bear assaying; for anything that promises to enlarge and deepen our conceptions of this evasive property of matter is well worth investigating.

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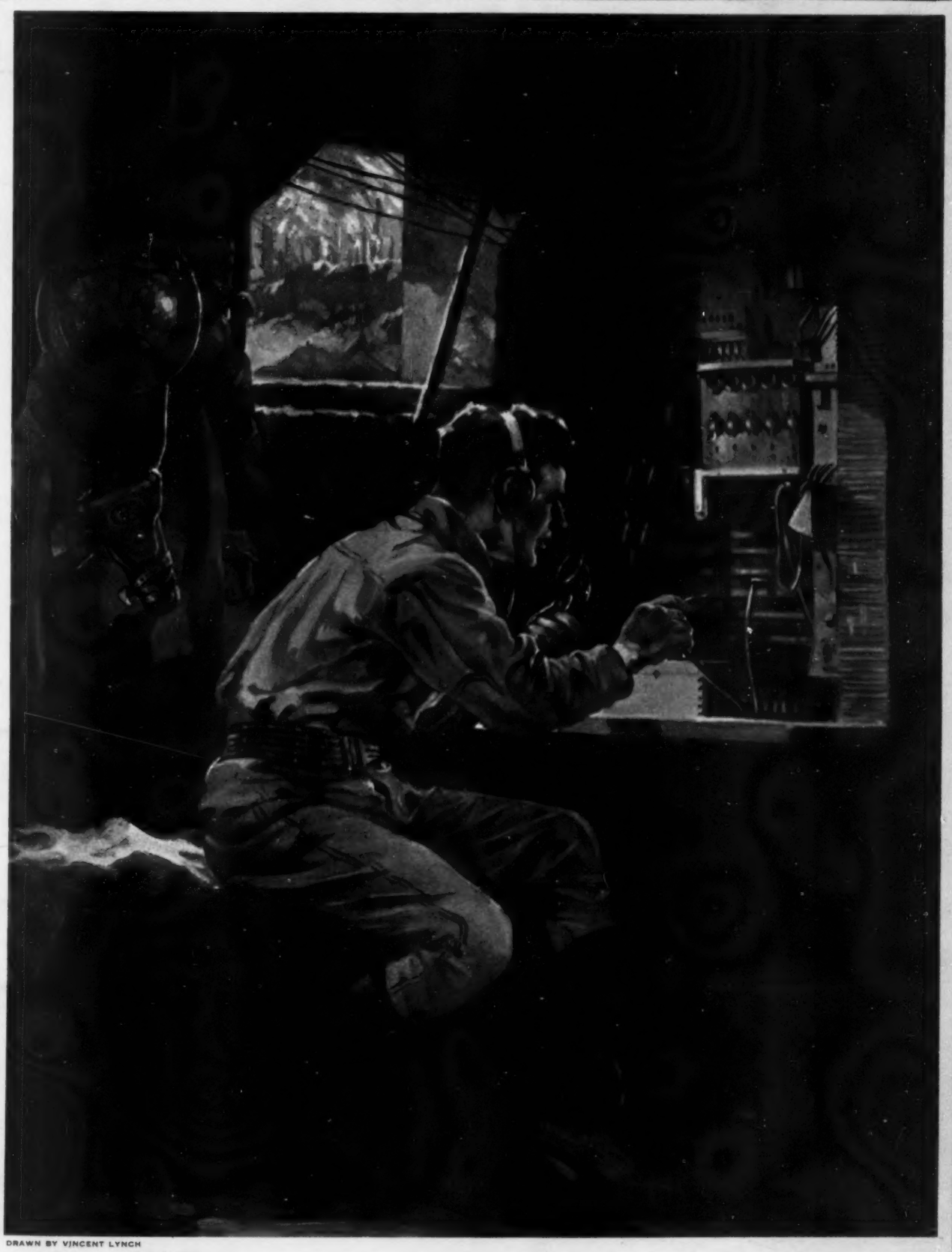

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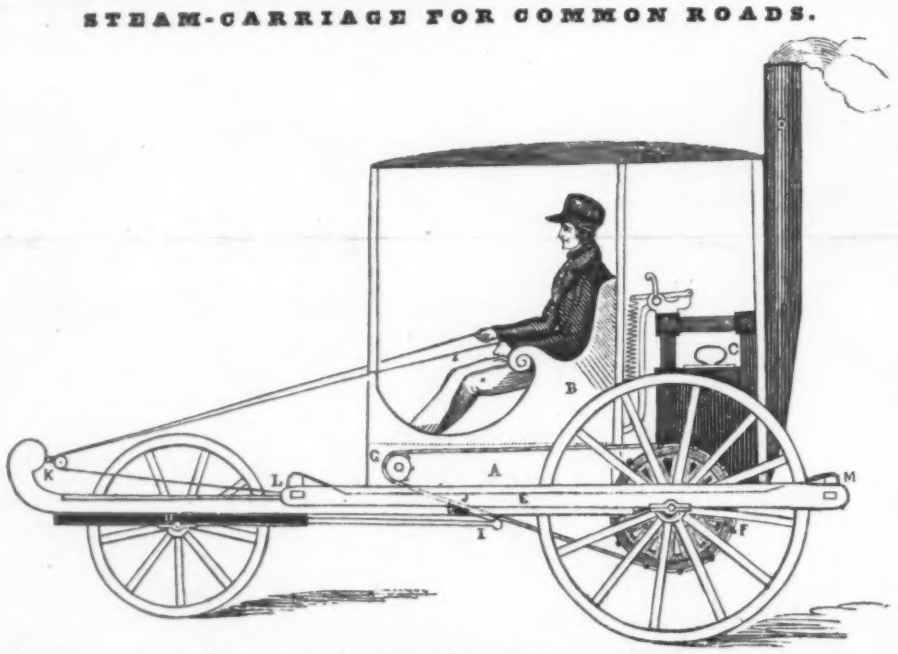
STEAM-CARRIAGE FOR COMMON ROADS.



EXPLANATION.—The body of the carriage, A, is about the size and capacity of those of an ordinary gig-waggon, with a convenient seat, B, for two riders; and under the seat is a box that will contain two or three bushels of coal. Behind the seat is the boiler, C, which consists principally of two rows of copper tubes, placed in a vertical position: and the two rows being parallel to each other, and ten inches apart, the fire is contained in the space between them, and is restrained from coming in contact with the tubes above the surface of the water within them: the smoke escapes by the funnel, O. A strong frame consisting of two parallel beams, E, connected by cross-bars, is made large enough to enclose the driving wheels, F, which are put in motion by an endless chain, which passes from the wheel, over the pulley, G; and the shaft of this pulley, passing through the body of the carriage, has a double crank under the floor of the carriage, and nearly under the rider's feet; and this crank is operated by two small engines, which are placed horizontally under the floor, and are operated by steam, which is conducted to them through a small pipe, from the top of the boiler. This carriage has but three wheels; and the forward or steering wheel, has its bearings in the sides of a horizontal circle, H. This horizontal circle is so constructed and mounted as to be moved rotarily on its own centre; and from the rearward side of this circle, a lever projects horizontally to I; and from the extreme end of this lever, a cord passes horizontally to the sides of the frame, near J; thence forward and over another pulley, K, and thence to the hands of the rider, where it meets another similar cord from the lever via the opposite side of the carriage. Thus by pulling one cord the steering-wheel is turned in one direction, and *vice versa*. The body of the carriage is hung on straps or braces extending from L to M, which secures the rider and machinery from any violent jolting which might otherwise be occasioned by the roughness of the roads. There is an arrangement in the machinery, which we shall describe, with an illustrative engraving, in a future number, and by which the power of the engines is applied to both driving-wheels equally and uniformly, notwithstanding the occasional excess of motion in one of the wheels, in passing corners or curves in the roads. Another peculiarity is, that the force applied, may be occasionally increased by leverage,—consequently reducing the speed,—to such an extent that one horse-power of steam will propell as great a load up-hill or otherwise, as can be drawn by six horses. One of the uses to which this carriage is intended to be applied, is to draw a plough or harrow; lift stumps and rocks, and do other agricultural work. For ploughing it will be requisite to have the rims of the wheels wider than for travelling, and the tire of the wheels must be furnished with teeth or projections to prevent the sliding of the wheels on the ground.

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